STUDIES ON CRICONEMATID NEMATODES

ABSTRACT

THESIS SUBMITTED TO
THE ALIGARH MUSLIM UNIVERSITY, ALIGARH
FOR THE AWARD OF THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN
ZOOLOGY

BY
Shahab Ahmad Rahmani

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SUPERVISOR

This is to certify that the entire research work presented in the thesis entitled "Studies on criconematid nematodes" by Mr. Shahab A. Rahmani is original and was carried out under my supervision. I have allowed Mr. Rahmani to submit it to the Aligarh Muslim University in fulfilment of the requirements for the degree of Doctor of Philosophy in Zoology.

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ABSTRACT

In the present work 55 species of nematodes belonging to the suborder Criconematina of the order Tylenchida have been described from specimens collected in India and Nepal. Fifteen genera under three superfamilies, four families and six subfamilies have been discussed and 36 known and 19 new species have been described. Of the 36 known species, 12 species are being recorded for the first time from India. An outline classification of Criconematina along with the diagnoses of different familial groups and genera has been provided. Identification keys to familial groups and genera of Criconematina and to Indian species of all the genera discussed in this work have also been given.

I. The suborder:

Criconematina Siddiqi, 1980

II. The superfamilies:

1. Criconematoidea Taylor, 1936 (Geraert, 1966)
2. Hemicycliophoroidea Skarbilovich, 1959 (Siddiqi, 1980)
3. Tylenchuloidea Skarbilovich, 1947 (Raski & Siddiqui, 1975)

III. The families:

1. Criconematidae Taylor, 1936 (Thorne, 1949)
2. Hemicycliophoridae Skarbilovich, 1959 (Geraert, 1966)

3. Caloosiidae Siddiqi, 1980

4. Paratylenchidae Thorne, 1949 (Raski, 1962)

IV. The subfamilies:

1. Criconematinae Taylor, 1936

2. Macroposthoniinae Skarbilovich, 1959

3. Hemicriconemoidinae Andrássy, 1979

4. Hemicycliophorinae Skarbilovich, 1959

5. Caloosiinae Siddiqi, 1980

6. Paratylenchinae Thorne, 1949

V. The genera:

1. Crossonema Mehta & Raski, 1971

2. Leptocriconema Mehta & Raski, 1971

3. Bathycriconema De Grisse & Loof, 1965

4. Lobocriconema Southern, 1914

5. Xenocriconemella Mehta & Raski, 1971 (Khan, Chawla & Saha, 1976)

6. Macroposthonia De Man, 1880

7. Criconemella De Grisse & Loof, 1965

8. Discocriconemella De Grisse & Loof, 1965

9. Xenocriconemella De Grisse & Loof, 1965

10. Hemicriconemoides Chitwood & Birchfield, 1957

11. Hemicycliophora De Man, 1921

12. Gracilacus Siddiqi, 1980

13. Caloosia Siddiqi & Goodey, 1964

14. Paratylenchus Micoletzky, 1922

15. Criconemoides Raski, 1962

VI. The known species:

1. Criconemoides curvatum Golden & Friedman, 1964

2. Criconemoides fimbriatum (Cobb in Taylor, 1936)
Mehta & Raski, 1971

3. Criconemoides fimcivatum Khan, Chawla & Saha, 1976

4. Criconemoides multisquamatum (Kirjanova, 1948)
Mehta & Raski, 1971

5. Leptocriconemoides oberrans (Jairajpuri & Siddiqi, 1963)
Andrássy, 1979

6. Lothericonema acriculum Raski & Pinochet, 1976

7. Lothericonema corbetti De Grisse, 1967

8. Lothericonema jaejuense Choi & Geraert, 1975

9. Lothericonema kovacsi (Andrássy, 1963)
De Grisse & Loof, 1967

10. Lothericonema mukcvum Khan, Chawla & Saha, 1976

11. Lyma coffeae (Edward, Misra & Rai, 1970) Andrássy, 1979

12. Lyma octaculare (Cobb, 1914) Sch. Stekhoven &
Teunissen, 1938

13. Scriconemoides impar Khan, Chawla & Saha, 1976

14. Scriconemoides tenuicaudata (Siddiqi, 1961)
Khan, Chawla & Saha, 1976

15. Macroposthonia basili (Jairajpuri, 1964)
De Grisse & Loof, 1965

16. Macroposthonia complexa (Jairajpuri, 1963)
De Grisse, & Loof, 1965

17. Macroposthonia obtusicaudatum (Heyns,1962) Heyns,1970
18. Macroposthonia onoense (Luc,1959) De Grisse & Loof, 1965
19. Macroposthonia onostris Phukan & Sanwal, 1980
20. Macroposthonia orwui(Siddiqi,1961) De Grisse & Loof, 1965
21. Macroposthonia rugium Khan, Chawla & Saha, 1976
22. Macroposthonia rugtica (Micoletzky,1915) De Grisse & Loof, 1965
23. Macroposthonia sphaerocephale (Taylor, 1936) De Grisse & Loof, 1965
24. Xenocriconemella macrodora (Taylor, 1936) De Grisse & Loof, 1965
25. Hemicriconemoides cocophillus (Loos, 1949) Chitwood & Birchfield, 1957
26. Hemicriconemoides mangiferae Siddiqi, 1961
27. Hemicycliophora dhirendri Husain & Khan, 1967
28. Auloaphora vostenbrinki (Luc, 1958) Siddiqi, 1980
29. Auloaphora penetrans (Thorne, 1955) Siddiqi, 1980
30. Calocosia indica Chawla & Sanathanam, 1980
31. Calocosia perelongicaudata Siddiqi & Ocoday, 1964
32. Paratylenchus baccaisanus Micoletzky, 1922
33. Paratylenchus halophilus Wouts, 1966
34. Paratylenchus minusculus Tarjan, 1960
35. Paratylenchus nainiensus Edward & Misra, 1963
36. Gracilacus sudrielius Brown, 1959.

VII. The new species:

1. Creasonema raskii
2. Neglobocricconema breviatylum
3. Neglobocricconema naseberrena
4. Nothocricconema corbulatum
5. Nothocricconema chanolii
6. Nothocricconema himalicum
7. Ogma paraoctangulare
8. Ogma parvum
9. Ogma unum
10. Macroposthonia paraexesta
11. Macroposthonia kalincai
12. Macroposthonia mandalenais
13. Criconemella andrássyi
14. Discocricconemella aquatica
15. Hemicriconemoides serratus
16. Hemicriconemoides indicus
17. Hemicriconemoides caudatus
18. Hemicyclionhora ceceri
19. Hemicyclionhora paraeubeolica

VIII. First records from India:

1. Creasonema fimbriatum (Cobb in Taylor, 1936) Mehta & Raski, 1971
2. Creasonema multistriematum (Kirjanova, 1948) Mehta & Raski, 1971

3. Lethocriconcma asticulum Raski & Pinochet, 1976
4. Lethocriconcma corbetti De Grisse, 1967
5. Lethocriconcma jaejuense Choi & Geraert, 1975
6. Macromathonia obtusicaudatum (Heyns,1962) Heyns, 1970
7. Macromathonia rustica (Micoletzky, 1915)
   De Grisse & Loof, 1965
8. Quinisulcius contenbrinki (Luc, 1958) Siddiqi, 1980
9. Quinisulcius acutecaudatus (Thorne, 1955) Siddiqi, 1980
10. Paratylenchus baldrhilus Wouts, 1966
11. Paratylenchus minusculus Tarjan, 1960
12. Gracilacus auriculatus Brown, 1959

IX. The new combination:

Quinisulcius utkali (Ray & Das, 1980) n. comb.

X. The synonyms:

1. Calcaonia parapani Phukan & Sarwal, 1979 of
   C. longicaudata (Loos, 1948) Siddiqi & Goodey,1964
2. Hemicycliophora damani Edward & Rai, 1970 of
   H. dhirendri Husain & Khan, 1967

ACKNOWLEDGEMENTS

The author wishes to express his sense of indebtedness to Dr. M. Shamim Jairajpuri for the supervision of the present work and for critically going through the manuscript.

Thanks are also due to Prof. S. Mashhood Alam, Head, Department of Zoology, Aligarh Muslim University for providing laboratory facilities. The co-operation of colleagues of the Nematology Research Laboratory is acknowledged here with thanks.

The financial assistance from Council of Scientific and Industrial Research, New Delhi is also gratefully acknowledged.

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INTRODUCTION

The criconematid nematodes possess small bodies; deeply annulated cuticle which may often be ornamented; oesophagus with fused prometacorpus, well developed valvular apparatus, isthmus and a small pyriform basal bulb; a long spear, metenchium usually longer than telenchium; monodelphic, prodelphic gonad and males rare, possessing degenerate spear and oesophagus. The usually peculiar ring-like appearance of these nematodes helps in easily distinguishing them from other nematode groups even at lower magnifications. The criconematids are cosmopolitan in distribution and live in diverse habitats. Some species prefer higher altitudes, while others are found at all the altitudes.

These animals depend entirely on their hosts for obtaining nutrition, but the economic importance of a majority of them is not known. They are ectoparasites on higher plants and are sure to cause damage to their hosts. Hemicycliophora spp. feed vigorously on their hosts and are considered important parasites. They attack beet, iris, lettuce and potato (Oostenbrink, 1958 & 59). Hemicycliophora typica was found causing damage to carrot (Kuiper, 1959). Paratylenchus spp., if present, in large populations in the rhizospheres of woody trees and bushes may cause serious damage to celery (Lownsberry et al., 1952; Oostenbrink, 1953), carrot (Oostenbrink, 1954), and fig (Thorne & Allen, 1950). In vineyards,

Paratylenchus spp. are found in large numbers (Meischer, 1960), also on roots of peach trees (Nesterove & Lisetskaya, 1963 & 65), in orchards of pear and apple (Braun et al., 1966; Fischer, 1967) etc. Almost all the species found in the vicinity of plant roots, but are not harmful until and unless their populations reach high densities. Species of Nothocriconema, Macroposthonia, Hemicriconemoides, Calcoaia, Hemicycliophora and Paratylenchus are generally known to occur in high numbers around their host roots.

During the last two decades, a large number of species of criconematid nematodes have been reported from all over the world including India. About 360 or more species of criconematid nematodes under different genera have been described so far. Prior to 1965, only 13 genera were known, viz., Bakernema, Caconaurus, Calcoaia, Criconema, Criconemoides, Gracilacus, Hemicriconemoides, Hemicycliophora, Macroposthonia, Paratylenchus, Sphaeronema, Trophotylenchus, Tylenchulus. Later, Criconema, Criconemoides and Hemicycliophora were split into several genera, also many other new genera were added and at present there are 33 genera in all under suborder Criconematina Siddiqi, 1980.

The oldest description of a criconematid nematode dates back to 1889, when Eubostrichus guernei was described by Certes. Richters (1904) collected similar specimens and recognised them as E. guernei of Certes. These were not real Eubostrichus,

because in fact the latter genus was that of a marine nematode described by Greef (1869). E. quernei had a spear and therefore was clearly a tylenchid. Hofmänner and Menzel (1914) studied E. quernei and found its body annules bearing continuous fringe of cuticular appendages. They described a similar type of new species and named it morgense. The latter differed from quernei in having smooth annules. A new genus, Criconema was proposed to accommodate the two species quernei and morgense. De Man (1880) described the genus Macroposthonia. Cobb (1913) raised the genus Iota for Iota aquamosum and also described Tylenchulus. Southern (1914) erected the genus Ogma and De Man (1921) the genus Hemicycliophora. Micoletzky (1922) described a male specimen under the name Paratylenchus bukowinensis. Cobb (1923) published a note on the Paratylenchus nematodes and also on a species of it. Micoletzky (1925) found that the genera Iota Cobb, 1913 and Ogma Southern, 1914 were synonyms and thus he regrouped the species of Criconema in such a way that the species with smooth annules were placed under Criconema while those with cuticular appendages on the annules were kept under Iota. Taylor (1936) thought Iota to be homonym and Ogma being congeneric with Criconema quernei had no standing. He transferred eight species to Criconema bearing spines or scale-like appendages on body annules, also proposed a new genus Criconemoides and a subfamily Criconematinae. Thorne (1943) erected the genus Cacopaurus for swollen female with the type C. pestis. De Coninck (1943) described

Criconema schuurmansstekhoveni and in 1945 gave an account of the variability of Criconema cobbi Micoletzky, 1925. Allen & Jensen (1950) described Cacopaurus apecris and Thorne & Allen (1950) a species of Paratylenchus. Tarjan(1952) revised the genus Hemicycliophora with addition of new species. Raski (1952) studied the morphology of Criconemoides Taylor, 1936 and in the same year Raski & Shor described Sphaeronema californicus, raised the genus Sphaeronema and the subfamily Sphaeronematinae. Oostenbrink (1953) published a note on Paratylenchus while Thorne (1955) presented an extensive study on Hemicycliophora and added 15 species to this genus. Raski (1956) described Sphaeronema arenarium and Jenkins (1956) Paratylenchus projectus. Raski (1957) proposed two new genera, Trophotylenchulus and Trophonema of which the former belonged to Pylenchulinae Skarbilovich, 1947 and the latter to Sphaeronematinae Raski & Shor, 1952. Chitwood & Birchfield (1957) proposed Hemicriconemoides and Chitwood in the same year described two species of Criconema. Goodey (1958) added Sphaeronema minutissum. Raski (1958) published two papers, one of which dealt with four new species of Hemicycliophora and other with the nomenclatural notes on Criconemoides along with a key to its species. Sauer (1958) described two species of Hemicycliophora and Luc (1958 & 59) three species of Hemicycliophora. Oostenbrink (1960) provided detailed observations on the family Criconematidae. Jenkins (1960) described Paratylenchus maryiandicus while Tarjan (1960) reviewed the

genus Paratylenchus. Wu (1960 & 61) described Criconema celatum and Paratylenchus tenuicaudatum. Raski (1962) proposed the genus Gracilacus for those species of Paratylenchus which possess long spears (above 41 um) and females becoming obese upon maturity. Siddiqi & Goodey (1964) reviewed Criconematidae and proposed the genus Calcaria. Wu (1964) raised the genus Bakernema. De Grisse & Loof (1965) and Loof & De Grisse (1967) revised Criconemoides and erected five new genera, viz., Lobocriconema, Nothocriconema, Criconemella, Xenocriconemella and Discocriconemella. They also re-established the genus Macroposthonia. Andrássy (1965) proposed Mesocriconema. Geraert (1966) while reviewing the order Tylenchida, raised Criconematidae to a superfamily and Criconematinae, Sphaeronematinae, Hemicycliophorinae to familial ranks. Loghossian (1966) described the genus Meloidoderita under the family Meloidoderitidae. Tarjan (1966) and Raski & Golden (1966) disagreed with the new generic proposals of De Grisse & Loof (1965) and synonymized them either with Macroposthonia or Criconemoides. Dasgupta et al. (1969) and Germani & Luc (1970) revised Hemicriconemoides and also described new species. Mehta & Raski (1971) reviewed Criconema and proposed some new genera and subgenera under it, viz., Blandicephalonema, Crossonema, Neoiheocriconema and Lateracephalonema, four subgenera (Criconema and Variasquamata) of the genus Criconema

and (Crossonema and Seriespinula) of the genus Crossonema. Raski (1973) proposed a new genus Paratylenchoides under Paratylenchidae Thorne, 1949 (Raski, 1962). Braaski (1974) studied in detail the taxonomy of Hemicycliophora and Calocaia and provided descriptions of several new species of Hemicycliophora. Raski & Siddiqi (1975) proposed the genus Tylenchocriconema with the family Tylenchocriconematidae and the superfamily Tylenchocriconematoidea. They also raised the family Tylenchuli ae to a superfamily level. Raski (1975) revised the genera Paratylenchus and Gracilacus. Khan et al.(1976) while reviewing the taxonomy of Criconematidae revalidated the genera proposed by De Grisse & Loof (1965) and also erected the genus Madinema and the family Madinematidae. Ray & Das (1978) proposed a new genus Hemicaloosia under Hemicycliophoridae. Besides these other workers have also contributed much to the taxonomy of this group of nematodes. Hundreds of new species have been described in the recent decades and perhaps even larger numbers await discovery. Andrássy (1979) divided family Criconematidae into four subfamilies, viz., Hemicycliophorinae, Macroposthoniinae, Criconematinae and Hemicriconemoidinae, described seven new species under various genera. He (l.c.) erected a new genus Colbranium for Hemicycliophora truncata Colbran, 1963, re-established the genus Gona Southern, 1914 and considered Criconema as genus Loquirende. Siddiqi (1980) erected the new suborder Criconematina for the criconematid nematodes and raised the family Hemicycliophoridae to a superfamily and also

proposed the family Calcocsiidae. He also split the genus Hemicycliophora into three genera, viz., Hemicycliophora, Anulophora and Loofia. Under Calcocsiidae Siddiqi included the genera Calcocsia and Hemicalcocsia.

The study of Criconematid nematodes in India strarted rather late. In 1961, Siddiqi for the first time published a paper on n w species of criconematids of different genera, viz., Criconema brevicaudatum, C. tenuicaudata, C. pruni, Criconemoides insigne, C. parvulum, Hemicriconemoides mangiferae, Hemicycliophora indica. He provided further observations on Criconema multiscutematum, Lcma octangulare, Criconemoides citri, Hemicriconemoides scoophillus and Hemicycliophora longicaudata. Khan & Basir (1963) described two species of Hemicycliophora from North India; Edward & Misra (1963) Peratylenchus neinianus; Jairajpuri (1963) Criconema aimleensis; Jairajpuri & Siddiqi (1963) three species of Criconemoides; Khan & Siddiqi (1963) Criconema serratum; Edward & Misra (1964) two species of Hemicriconemoides and two of Criconemoides; Jairajpuri (1964) three species of Criconemoides and one of Criconema; Khan & Siddiqi (1964) Criconema laterale from Kashmir; Swarup et al. (1964) recorded some criconematid nematodes from India; Edward et al. (1965) Hemicriconemoides birchfieldi; Prasad et al. (1965) Criconemoides georgii; Siddiqi (1965) Criconemoides citricola and a redescription of Criconema murrayi Southern, 1914;

Edward & Misra (1966) and Edward *et al.* (1967) several species of criconematid nematodes; Husain & Khan (1967) *Hemicycliophora dhirendri* and other nematodes; Khan *et al.*(1967) two species of *Paratylenchus*; Mathur *et al.* (1967) one species of *Paratylenchus*; Mathur *et al.* (1969) two species of *Calcaisia*; Edward *et al.* (1970) *Criconema coffeae*; Edward & Rai (1970) *Hemicycliophora demani*; Edward *et al.* (1971) *Criconema punici*; Khan *et al.* (1971) five new species of criconematid nematodes from Kerela; Misra & Edward (1971) *Hemicycliophora mangiferum*; Suryawanshi (1971) four species of criconematids from Marathwada, India; Khan & Nanjappa (1972) two species each of *Nothocriconema* and *Hemicycliophora*; Jairajpuri & Baqri (1973) *Hemicycliophora subadica*; Mahajan & Bijral (1973) one species of each *Criconemoides* and *Variasumata sensu lato*; Singh & Khera (1975) *Criconemoides brevistylus*; Khan *et al.* (1976) reviewed Criconematidae, proposed new family Madinematidae, nine new species under different genera; Prasad (1976) *Calcaisia heterocephala*; Das & Shivaswamy (1977) *Hemicycliophora demani*; Baqri (1979) *Crecilecus jenii* and *Nothocriconema decrissei* and observations on *Hemicriconemoides cocophillus*, *H. mangiferae*, *Macroposthonia ornata*, *M. onoensa* and *Paratylenchus dianthus*; Dhanachand & Jairajpuri (1980) *Hemicriconemoides neobrachyurus* and *Hemicalcaisia luci* from Manipur; Phukan & Sanwal (1979) two species of *Crecilecus* and *Paratylenchus* from Jorhat, Assam; Phukan & Sanwal (1980) *Calcaisia parapexi*; Ray & Das (1980)

Calcocis triannulata and Hemicycliophora utkali from Orissa and Phukan & Sanwal (1980) two species of Macroposthonia, etc.

As is evident from the above account a large number of species of various genera of criconematid nematodes are already known from this country. The species of Crossonema, Macroposthonia, Hemicriconemoides, Hemicycliophora, Calcocis, Paratylenchus, etc., are widely distributed in India; others like those of Neoiobocriconema, Nothocriconema, Lobocriconema, Seriespinula, Criconemella, Discocriconemella, Xenocriconemella, Aulosphora, Leofia, Cracilacus, etc., have restricted distribution while the species of Tylenchocriconema, Tylenchulus, Trophotylenchulus, Paratylenchoides, Cacopaurus, Sheeronema, Irophonema and Meloidoderita have not so far been recorded from this country.

For the present work soil samples were collected from different localities in Uttar Pradesh, Gujarat, Orissa, Karnataka, Tamil Nadu, Kerala, Manipur, Assam, Nagaland and Jammu & Kashmir. A few samples were also obtained from Nepal. Samples collected from hilly areas (altitude varying from 400 - 3000 m), viz., Nainital, Ranikhet, Almora, Chamoli, Dehradun, Mussoorie, Rishikesh in Uttar Pradesh; Bangalore and Mysore in Karnataka; Ootacamund in Tamil Nadu; Mukkali, Silent Valley and nearby hills in Kerala; Srinagar in Jammu & Kashmir, etc., were usually found rich in criconematids.

However, species of Macroposthonia, Hemicriconemoides, Hemicycliophora, Calcensis and Paratylenchus were found in samples collected from the hills as well as plains. During the entire course of this work six expeditions were made for the collections of material for the study. These were in March,1978; May,1978; October,1978; March,1979, September,1979 and August,1980. A total of more than 300 samples were brought to the laboratory and were processed for the recovery of circonematid nematodes. The material collected in these surveys represents the following fifteen genera belonging to three superfamilies of Criconematina, viz., Criconematoidea, Hemicycliophoroidea and Tylenchuloidea: Crossonema, Neoloboriconema, Nothocriconema, Ogma, Seriespinula, Macroposthonia, Criconemella, Discocriconemella, Xenocriconemella, Hemicriconemoides, Hemicycliophora, Aulosphora, Calcensis, Paratylenchus and Gracilacus. Fifty five species of these genera, which include both known and new, have been recorded.

The present work provides a detailed account on the systematics of Criconematina followed by the descriptions of the genera and species that were recorded. The chapter on the systematics of Criconematina provides elaborate diagnoses of all the groups up to subfamily level along with the keys to genera under each subfamily. The descriptions of species have been provided under various genera. First the diagnosis of the genus has been given followed by some comments and an

up-to-date list of species recognized under that genus. After this, the descriptions of species, old or new, follow and end up with a key to species of that particular genus found in India. In all, 36 known species are recorded and 19 new species have been described in adequate details. However, illustrations of all the known as well as new species have been provided. Of the 55 species that are being reported in the present work, four known and one new belong to Crossonema, one known and two new to Neoloboriconema, five known and three new to Nothocriconema, two known and three new to Orma, two known to Seriamimula, nine known and three new to Macroposthonia, one new to Criconemella, Discocriconemella each, one known to Xenocriconemella, two known and three new to Hemicriconemoides, one known and two new to Hemicycliophora, two known to Aulosphora, two known to Calcaia, four known to Paratylenchus and one known to Gracilacus. The following 12 known species are new records from India: Crossonema fimbriatum, C. multiannulatum, Nothocriconema acriculum, N. corbetti, N. insulanse, Macroposthonia obtusicaudatum, M. rustica, Aulosphora goetzbrinki, A. penetrans, Paratylenchus halophilus, P. minusculus and Gracilacus sudriellus. For already known species detailed measurements, habitats, localities and remarks, if any, are given except for Hemicycliophora ghirendri Husain & Khan,1967 which has been described in detail.Males are recorded only

in Macroposthonia kalincai n. sp., M. bruni, Hemicriconemoides mangiferae, H. serratus n. sp., Calcaeis indica and C. pseudoneocaudata. The following species were widely distributed and collected from many localities: Crossonema fimcivatum, Neoloboocriconema aberrans, Coma octangulare, Macroposthonia complexa, M. obtusicaudatum, M. onoensis, M. bruni, M. rustica, M. sphaerocephala, Discocriconemella aquatica n. sp., Xenocriconemella macrodora, Hemicriconemoides cocophillus, H. mangiferae, Hemicycliophora dhirendri, Aulosphora costenbrinki, Calcaeis pseudoneocaudata, Paratylenchus boscekianus, P. nainianus.

MATERIAL AND METHODS

Soil sampling:

Soil samples from around roots of fruit trees, flowering plants etc. from a depth of 5-25 cm were collected. These samples were stored in polythene bags and were brought to the laboratory for analysis.

Processing of samples:

About 500 gm of soil was added to a bucket filled to one-third of its capacity with water and then it was mixed thoroughly. The muddy suspension was stirred gently while the bucket was being filled to its full capacity with water. The suspension was allowed to stand undisturbed for some time and was then passed first through a coarse sieve for removing debris etc. The whole aliquot was then passed through a 300 mesh sieve (pore size 53 um). The nematodes were retained on the sieve while water and the fine soil particles passed through it. The entire 'catch' was poured in a beaker.

Isolation of nematodes:

The above 'catch' was placed on a tissue paper which was kept on a coarse sieve and this was fitted on a Baermann's funnel which was filled with water touching the bottom of the coarse sieve. The criconematid nematodes being sluggish in

their movements were often retained on the tissue paper and hence direct picking was always done in order to obtain a good number of specimens.

Killing and fixation:

The suspension of nematodes obtained from the Baermann's funnel was put into tubes and these were allowed to stand undisturbed. Later the supernatant was discarded and the concentrated suspension of nematodes was then transferred to a cavity - block. The excessive water was further removed from the cavity - block with the help of a fine-nasal dropper. The nematodes were then killed and fixed by using hot (60-65°C) 8 percent formalin solution (double strength). The hot formalin was poured in the cavity - block containing nematodes and these were left as such for 24 hours and were stored in the same solution.

Mounting and sealing:

For the preparation of permanent mounts the nematodes were picked with the help of a sharp bamboo needle and were transferred to a cavity - block containing glycerine - alcohol (95 parts 30% alcohol and 5 parts glycerine). The cavity - block was then kept in a desiccator at room temperature for gradual dehydration. After 2-3 weeks, the dehydrated nematodes were mounted in anhydrous glycerine. Pieces of glass-wool of

suitable thickness were placed between two coverslips of the aluminium slides so as to prevent flattening of specimens. The coverslips were sealed either with 'cutex' nail polish, or glycerol or with 'putty'. The last one is a newly discovered sealing medium (Jairajpuri & Rahmani, 1979).

Measurement and drawings:

Measurements were taken with the help of an ocular micrometer. Illustrations were made with a camera lucida. Some of the symbols used by De Grisse (1964) were added to De Manian formula. These are: R = total number of body sheath annules; RV = annules on which vulva is located from posterior extremity; RVan = number of annules between vulva and anus; Ran = annules on which anus is located from posterior extremity; Rex = annules on which excretory pore is located from anterior extremity; VL/VB = distance from terminus to vulva divided by body-width at vulva. In addition, following symbols are also used: Rst = annules from anterior extremity to base of spear; R oeso = annules from anterior extremity to base of oesophagus.

In the text um stands for μm.

Type material:

The type material has been adequately labelled and deposited with the Zoology Department of Aligarh Muslim University, Aligarh, India.

SYSTEMATICS OF CRICONEMATINA

In 1936, Taylor proposed a subfamily Criconematinae for accommodating all the species of *Criconema*, *Hemicycliophora*, *Paratylenchus* and *Criconemoides* known till that time. Thorne (1949) raised Criconematinae to the rank of a family under the superfamily Tylenchoidea Filipjev, 1934 (Chitwood & Chitwood, 1937). Geraert (1966) raised Criconematidae to a superfamily under the suborder Tylenchina Geraert, 1966. Very recently, Siddiqi (1980) has proposed a separate suborder Criconematina for the criconematid nematodes because of their peculiar ring-like, short and plump bodies with or without an extracuticular sheath, cuticle ornamented with scales, spines or other appendages, without distinct phasmids and with marked sexual dimorphism.

In the following the diagnoses of the suborder Criconematina, and of the superfamilies, families and subfamilies included under it have been provided. Keys to the familial groups, and genera under each subfamily has also been given. The authorities of the familial groups etc., are according to Siddiqi (1980). The name of the familial group is followed by the name(s) of the original proposer with date. The name(s) within parenthesis after the name(s) of the original proposer are of those author(s) who changed its rank.

SUBORDER CRICONEMATINA SIDDIQI, 1980

Diagnosis: Tylenchida. Females cylindrical, sausage-shaped or spheroid with well developed oesophagus. Females and juveniles with thick cuticle marked with retrorse or smooth annules without lateral fields or provided with spines, scales or other cuticular configuration or with smooth, coarse rounded annules, which may be covered with or without an extracuticular sheath. Lip region in female and juvenile with usually less than three usually modified annules; oral apertures dorso-ventrally longitudinal, often 4-sheeted due to two lateral liplets or a raised area or labial disc; amphidial apertures round to oval. Three or four submedian pseudolips and two small lateral pseudolips. Cephalic framework hexo-radiate to with weak or strong sclerotization. Deirids reported in Tylenchulus and Paratylenchus. Phasmids absent. Spear long, metenchium longer than telenchium; basal knobs of spear well developed, sloping backwards or anchor-shaped with outer margins directed forwards (occasionally with blunt margins). Oesophagus with procorpus amalgamated with metacorpus, isthmus slender and set off from basal bulb or short and broad amalgamated with the basal bulb. Basal bulb small, containing oesophageal gland. Orifice of dorsal oesophageal gland behind spear base. Oesophago-intestinal valve indistinct. Vulva transversely oval, or slit like, located posteriorly usually at over 75 per cent of body length. Gonad monoprodelphic; ovary

outstretched (coiled in swollen females or reflexed in some forms of Macroposthonia). Post-vulval uterine sac usually absent. Spermatheca rounded to oval, set off. Uterus with ovijector. Vagina leading inward and forward. Intestine syncytial, lacking a definite lumen, often extending beyond anal level, female anus a small pore. Sexual dimorphism distinct. Males slender and degenerate, oesophageal region and spear degenerate, monorchic, gonoduct mostly filled with small sized sperms. Testis in mature males obliterated. Spicules often very long and setaceous with small narrow head, an elongate-slender shaft and finely pointed distal ends, variable in shape, often arcuate. Cuticular crescent-shaped in lateral view. Bursa low, rarely elevated or drawn out as a penial tube.

Type superfamily:

Criconematoidea Taylor, 1936 (Goseert, 1966)

Other superfamilies:

Hemicycliophoroidea Skarbilovich, 1959 (Siddiqi, 1980)

Tylenchocriconematoidea Raski & Siddiqui, 1975

Tylenchuloidea Skarbilovich, 1947 (Raski & Siddiqui 1975)

KEY A FAMILIAL GROUPS OF CRICONEMATINA

1. Females and juveniles eel-like with non-retrorse annules; basal knobs of spear sloping (not anchor-shaped) male development normal, with long tail and bursa .....
Hemicycliophoroidea Skarbilovich, 1959 (Siddiqi, 1980) ... 2

Females and juvenile spindle-or sausage-shaped with re - trorse annules (exce t in Hemicriconemoidinae); basal knobs of spear anchor-shaped with margins anteiorly directed or blunt; male development through metamorphosis , with spined juveniles; tail and bursa short ..... Criconemetoidea Taylor, 1936 (Cereert, 1966) ..... Criconematidae Taylor, 1936 (Thorne, 1949) 3

Females slender; adults and juveniles with fine cuticular annules which are not retrorse; oesophagus with a long slender isthmus not amalgamated with the basal bulb 5

2. Females with thick cuticular sheath; lip annules not modified; vulval lips modified in some form; spicules not straight ..... Hemicycliophoridae Skarbilovich, 1959 (Cereert, 1966) .. .. Hemicycliophorinae Skarbilovich, 1959

Females with or without cuticular sheath; lip annules modified; vulval lips not modified; spicules straight ... . Caloosiidae Siddiqi, 1980 .... Caloosiinae Siddiqi,1980

3. Females with annules bearing spines, scales or other configurations .....Criconematinae Taylor, 1936

Females with annules smooth or crenate not bearing spines scales or other configuration 4

4. Females body surrounded by an extra-cuticular sheath; annules smooth to lightly cronate behind vulva; spear knobs anchor-shaped (with blunt anterior margins in some forms); submedian lobes absent ..... Hemicriconemoidinae Andrássy, 1979

Females body not surrounded by an extracuticular sheath; annules smooth to finely or heavily cronate; spear knobs anchor-shaped; submedian lobes present ..... Macroposthoniinae Skarbilovich, 1959

5. Females nearly 0.5 mm or more; males with symmetrical lip region and bursa terminal ..... -ylenchocriconematoidea Raski & Siddiqui 1975 ..... Pylenchocriconematidae Raski & Siddiqui 1975

Females under 0.5 mm; males with symmetrical lip region and bursa subterminal ..... Pylenchuloidea Skarbilovich, 1947 (Raski & Siddiqui, 1975) 6

6. Spear over 20 um long with metarchium longer than telen - chium; females vermiform or enlarged on all sides; males with short-cylindrical tail .... Paratylenchidae Thorne, 1949 (Raski,1962) ..... Paratylenchinae Thorne, 1949

Spear under 20 um; usually 15 um; with metarchium e qual to telenchium; females sub-spherical or elongate-saccate with body mostly enlarging dorsally; males with elongate-conoid tails 7

7. Excretory pore posterior to oesophagus, leading to an excretory duct directed anteriorly; females not sub-spherical; post-vulval region present ..... Tylenchulidae Skarbilovich, 1947 (Kirjanova, 1955)
Excretory pore at or near oesophagus, leading to an excretory duct directed posteriorly; females sub-spherical; post-vulval region absent 8

8. Uterine wall abnormally thickened to form a cyst or death; bursa distinct ..... Meloidoderitidae Kirjanova & Pogossian, 1973
Uterine wall not forming a cyst or death; bursa indistinct or absent ..... Sphaeronematidae Raski & Sher, 1952 (Coraert, 1966) ..... Sphaeronematinae Raski & Sher, 1952

SUBFAMILY CRICONEMATOIDEA TAYLOR, 1936 (GERAERT, 1966)

Diagnosis: Criconematina. Body in both sexes about 1 mm long. Sexual dimorphism present. Body cuticle heavily annulated, annules smooth, coarse, bearing scales, spines or other spine-like retrorse projections. Labial framework slightly sclerotized, in a number of species median lobes well developed. Oesophagus criconematoid. Vulva posterior. Males degenerate in oesophageal region, lacking spear. Spicules slightly arcuate. Gubernaculum small trough-shaped. Bursa absent or poorly developed.

Type and only family:

Criconematidae Taylor, 1936 (Thorne, 1949)

FAMILY CRICONEMATIDAE TAYLOR, 1936 (THORNE, 1949)

Diagnosis: Criconematoidea. Female body small and stout, cigar- or sausage-shaped, straight to curved slightly ventrally, anteriorly blunt, sometimes tapering posteriorly. Cuticle broadly and heavily annulated, annules often retrorse, smooth to finely crenate, or ornamented with scales, spines or other appendages, often arranged in longitudinal rows. Annules 24-200 in numbers. Lip region made up of one or two annules, lips small, fused in to a labial disc connected with 6, more or less developed elevations, the pseudolips. Spear very long and

strong, 45-100 um. Basal knobs large. Median bulb large, isthmus very short, hardly differentiated from basal bulb. Rectum and anus inconspicuous. Ovary pro-vulvar, mostly straight, without post-vulvar sac. Vulva posterior, well behind three-fourth of total body length. Males slender than female and reduced in organization. Cuticle finely annulated, never possessing appendages. Spear lacking, oesophagus non-functioning. Spicules long and slender. Bursa strongly reduced or absent. Males very rare. Cuticle of juvenile coarsely annulated, with or without scales or spines; if these are present they are arranged in longitudinal rows generally more numerous than those of mature females.

Type subfamily:

Criconematinae Taylor, 1936

Other subfamilies:

Macroposthoniinae Skarbilovich, 1959

Hemicriconemoidinae Andrássy, 1979

SUBFAMILY CRICONEMATINAE TAYLOR, 1936

Diagnosis: Criconematidae. Body cuticle coarsely and broadly annulated, without an external sheath. Annules 26-134, retrorse, ornamented (at least in juvenile stages) with scales, spines or finger-like appendages arranged either in longitudinal

rows or continuous transverse fringes. Lip region set off, pseudolips present, frequently forming lobes. Lateral fields in females absent. Spear knobs directed forward. Tail short, conical or rounded. Males with degenerate oesophagus and spear. Spicules curved ventrally. Cubernaculum and reduced bursa present.

Type genus:

Criconema Hofmänner & Menzel, 1914

Other genera:

Bakernema Wu, 1964

Blandicephalenema Mehta & Raski, 1971

Crossarinema Khan, Chawla & Saha, 1976

Crossonema Mehta & Raski, 1971

Neoloboccriconema Mehta & Raski, 1971

Lotharicconema De Grisse & Loof, 1965

Ogma Southern, 1914

Paratescuchalenema Mehta & Raski, 1971

Seriospinula Mehta & Raski, 1971 (Khan, Chawla & Saha, 1976)

KEY TO GENERA OF CRICONEMATINAE

1. Annules on mature females smooth, without any scales, spines or finger-like appendages ..... Lotharicconema

Annules on both juveniles and mature females with scales, spines or finger-like appendages 2

2. Annules not striated or crenate, bearing appendages of same type over entire length of body 3
Annules striated on anterior body with crenate margins, on posterior end ornamented by lobes or other appendages .... Anoigheericonema

3. Cuticular appendages without longitudinally arranged rows.. 4
Cuticular appendages with longitudinally arranged rows 5

4. Outgrowths of cuticle transparent, membranous, hardly discernible; lip region not separate, bearing appendages similar as on body annules ..... Bekarnema
Outgrowths of cuticle definite, well discernible; lip region separate, smooth or slightly fringed ..... Crossonema

5. Cuticular appendages in continuous rows, not alternating, not palmate 6
Cuticular appendages in alternating rows, palmate with finger-like lobes ..... Croserinema

6. Lip region provided with submedian lobes ..... Lyme
Lip region not provided with submedian lobes 7

7. Lip region normally large with forward or laterally directed outlines consisting mostly of two annules 8
Lip region usually small, convex with backward bent outline consisting of one annule .....Blendicephalenema

8. Lip region with one annule (occasionally two); vulval lips open ..... Pataracanhelenens

Lip region with two annules; vulval lips closed .... Seriesannula

SUBFAMILY MACROSTOMONIINAE SKARBILOVICH, 1959

Diagnosis: Criconematidae. Body cylindrical, tapering towards extremities. Body cuticle coarsely annulated, annules 40-200 smooth or finely crenate. Extracuticular sheath and lateral fields absent, lip region usually distinct, not set off, oral disc surrounded by pseudolips often forming four submedian lobes. Spear knobs anteriorly directed. Tail short, conoid or rounded. Spicules curved ventrally, slightly, bursa rudimentary if present. Larval cuticle smooth, at the most wavey or slightly fringed, without scales or spines, arranged in longitudinal rows.

Type genus:

Macroposthonia De Man, 1880

Other genera:

Criconemella De Grisse & Loof, 1965

Discocriconemella De Grisse & Loof, 1965

Xenocriconemella De Grisse & Loof, 1965

Lethocriconemoides Mass, Loof & De Grisse, 1971

Criconemoides Taylor, 1936

KEY TO GENERA OF MACRO OSTHONIINAE

1. Spear rather short, well under 40% of body length, not flexible 2

   Spear very long, about 40% of body length, flexible .... Xenocriconemella

2. Lip annules disc-or saucer-shaped, pseudolips fused, body annules often showing anastomoses ..... Discocriconemella

   Lip annules normal neither disc-nor saucer-shaped; pseudolips not fused; body annules only rarely showing anastomoses 3

3. Body small 0.3 mm; densely annulated; R = 100-200; submedian lobes absent ..... Cricnemella

   Body moderate to large, 0.4-0.6 mm; coarsely annulated; R = 40-150; submedian lobes present 4

4. Vulva open ..... Macroposthonia

   Vulva closed 5

5. Lip region made up of three annules; first thin narrow; second broad, and third narrow again, collar-like; vulva with overhanging anterior lips .....Nothocriconemoides

   Lip region made up of single annule; anterior vulval lip not overhanging ..... Criconemoides

SUBFAMILY HEMICRICONEMOIDINAE ANDRÁSSY, 1979

Diagnosis: Criconematidae. Body of females and juvenile surrounded by an extracuticular sheath, body not retrorse, fairly flat in outline, without any appendages in adult females. Lip region usually not set off, pseudolips hardly developed, not forming median lobes. No lateral fields. Spear knobs blunt to anchor-shaped. Tail conoid to rounded, short. Male cuticle simple. Bursa reduced or absent, spicules curved ventrally. Larval cuticle ornamented with scales which are generally arranged in alternating rows.

Type and only genus:

Hemicriconemoides Chitwood & Birchfield, 1957

SUPERFAMILY HEMICYCLIOPHOROIDEA SKARBILOVICH, 1959 (SIDDIQI,1980)

Diagnosis: Criconematina. Body in both sexes moderate to large (0.6-19 mm). Sexual dimorphism present. Body cuticle bearing coarse, non-retrorse annules usually numbering over 200. Juveniles and adult females with an extra cuticular sheath, except in Calcensia. Lip region with 1-3 annules. Oral opening or dorsoventral slit on a labial disc. Amphidial apertures close to labial disc. Submedian lobes absent. Lateral fields absent in juveniles and Calcensia females. Spear elongated, basal knobs sloping. Vulva oval, transverse, or slit like, usually with modified lips, located in posterior region of body. Monodelphic, prodelphic gonad. Tail differently shaped usually elongated and pointed, rounded, cylindrical or hemispherical. Males with degenerate spear and oesophagus, tail elongated, tapering with conspicuous bursa. Spicules setaceous, and long, weakly cephalated, straight, arcuate, semi-circular 'U'-or hook-shaped. Gubernaculum fixed. Cloacal lips may form penial tube in some forms.

Type family:

Hemicycliophoridae Skarbilovich, 1959 (Cernort, 1956)

Other family:

Calcensiidae Siddiqi, 1980

FAMILY HEMICYCLIOPHORIDAE SKARBILOVICH, 1959 (GERAERT, 1966)

Diagnosis: Hemicycliophoroidea. Body of adult females and juveniles with an extracuticular sheath. Lip annules of females not modified or separate (except in Hemicycliophora hosseria). Vulva a transverse slit one half a body-width long and marked by a discontinuity in ventral body-contour (except in Loofia); vulval lips modified and projecting (except in Loofia). Male lip region usually set off. Spicules arcuate, semi-circular, U- or hook-shaped. Male gonopore elongated in to a penial tube. Bursa covers one third of tail. Male tail longer than female. Female tail usually elongate conoid but may be filiform, cylindrical or hemispherical. Males degenerate especially its oesophagus and spear.

Type and only subfamily:

Hemicycliophorinae Skarbilovich, 1959

SUBFAMILY HEMICYCLIOPHORINAE SKARBILOVICH, 1959

Diagnosis: Hemicycliophoridae. Body of female with extracuticular sheath; body annules not retrorse. Lip region not set off. Lateral fields may be present. Males lack spear and degenerate oesophagus. Spicules arcuate, semi-circular, U- or hook-shaped. Gubernaculum small, trough-shaped. Adanal bursa may or may not be present.

Type genus:

Hemicycliophora De Man, 1921

Other genera:

Gulophora Siddiqi, 1980

Colbrenium Andrássy, 1979

Loofia Siddiqi, 1980

KEY TO GENERA OF HEMICYCLIOPHORINAE

1. Females with modified vulval lips, often elongated and pointed; body just posterior to vulva recessed; spicules semi-circular, L- or hook-shaped 2
   Female without modified vulval lips, often rounded, low; body just posterior to vulva not recessed; spicules arcuate 3

2. Vulval lips less than three body annules long, usually not parallel; spicules semi-circular; gonopore divides bursa in to nearly two equal, pre- and post-anal parts in the ratio of 1:1 ..... Hemicycliophora
   Vulval lips more than three body annules long; almost parallel; spicules L- or hook-shaped; gonopore divides bursa in to two unequal, pre- and post-anal parts in the ratio of 3-4:1 ..... Gulophora

3. Female lip region set off by a deep constriction ; vulva and anus subterminal; bursa reaching almost to tail tip. ..... Colbrenium

Female lip region not set off; vulva and anus not subterminal; bursa short not reaching to tail tip ..... Acontia

FAMILY CALOOSIIDAE SIDDIQI, 1980

Diagnosis: Hemicycliophoroidea. Body of adult females and juveniles with or without an extracuticular body sheath; sheath if present, membranous, much thinner and closely adpressed to body cuticle. Main annules separated, usually modified. Lateral fields absent. Vulva transversely oval, less than half a body width long; anterior lip of vulva modified, partly overhanging vulva, posterior lip not modified. Spicules straight. Lips of cloacal aperture not elongated to form a penial tube. Bursa usually covering more than one-third of the tail.

Type and only subfamily:

Caloosiinae Siddiqi, 1980

SUBFAMILY CALOOSIINAE SIDDIQI, 1980

Diagnosis: Caloosiidae. Females and juveniles eel-like with or without extracuticular sheath. Annules non-retrorse; lip region set off and with modified annules; basal knobs of spear not anchor-shaped, spicules straight.

Type genus:

Caloosia Siddiqi & Goodey, 1964

Other genus:

Hemicalcosia Ray & Das, 1978

KEY TO GENERA OF CALCOSIINAE

Body with a thin closely adpressed membrane over body cuticle ..... Hemicalcosia

Body without a thin membrane over body cuticle .....

..... Calcosia

SUPERFAMILY TYLENCHOCRICONEMATOIDEA RASKI & SIDDIQUI, 1975

Diagnosis: Criconematina. Body of both sexes cylindrical, body annules fine; cuticle almost smooth in outline. Spear very slender in anterior portion. Oesophagus criconematoid type. Marked sexual dimorphism. Male lip region asymmetrical, inclined ventrally, spear lacking, oesophagus degenerate. Bursa well developed, extending to tail tip.

Type and only family:

Tylenchocriconematidae Raski & Siddiqui, 1975

FAMILY TYLENCHOCRICONEMATIDAE RASKI & SIDDIQUI, 1975

Diagnosis: Tylenchocriconematoidea. Body cylindrical, cuticle very finely annulated almost smooth. Lip region distinct. Spear well developed, slender anteriorly. Males shorter than female with an asymmetrical lip region and degenerate oesophagus and spear.

Type and only genus:

Tylenchocriconema Raski & Siddiqui, 1975

SUPERFAMILY TYLENCHELOIDEA SKARBILOVICH, 1947 (RASKI & SIDDIQI,1975)

Diagnosis: Criconematina. Body in both sexes small sized, less than 0.6 mm in length. Adult females becoming swollen in most groups. Body cuticle with fine annules, not retrorse. Spear mostly small, but long and slender in some groups. Procorpus enlarges without constriction and merges with large oval metacorpus. Isthmus distinct, slender, not amalgamated with basal bulb. Marked sexual dimorphism. Males with symmetrical lip region, subterminal or reduced bursa.

Type family:

Tylenchulidae Skarbilovich, 1947 (Kirjanova, 1955)

Other families:

*Meloidoderitidae Kirjanova & Eghossian, 1973

Paratylenchidae Thorne, 1949 (Raski, 1962)

Sphaeronematidae Raski & Sher, 1952 (Geraert, 1966).

FAMILY TYLENCHULIDAE SKARBILOVICH, 1947 (KIRJANOVA, 1955)

Diagnosis: Tylenchuloidea. Adult females small sized, not subspherical, body with a post-vulval region. Excretory pore much posterior to oesophagus, leading to an excretory duct directed anteriorly.

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* Family Meloidoderitidae not diagnosed due to lack of information.

Type and only subfamily:

Tylenchulinae Skarbilovich, 1947

SUBFAMILY TYLENCHULINAE SKARBILOVICH, 1947

Diagnosis: Tylenchulidae. Females not sub-spherical. Oesophagus with a pyriform basal bulb. Excretory pore well posterior to nerve ring. Male spear present but reduced.

Type genus:

Tylenchulus Cobb, 1913

Other genus:

Trophotylenchulus Raski, 1957

KEY TO GENERA OF TYLENCHULINAE

Excretory pore subequatorial; outlet of dorsal oesophageal gland about a spear length from base of spear .... *Tylenchulus*

Excretory pore anterior to midbody, being 33-44% from anterior end; outlet of dorsal oesophageal gland about half of spear length from base of spear ..... *Trophotylenchulus*

FAMILY SCUTELLONEMATIDAE RASKI & SHER, 1952 (GERAERT, 1966)

Diagnosis: Tylenchuloidea. Female body small. Subspherical, body without a post-vulval region; excretory pore at or near

oesophagus, leading to excretory duct directed posteriorly.

Type and only subfamily:

Sphaeronematinae Raski & Sher, 1952

SUBFAMILY SPHAERONEMATINAE RASKI & SHER, 1952

Diagnosis: Sphaeronematidae. Females subspherical to obese, with pyriform basal bulb. Cuticle rather thick, sometimes with distinct reticulate pattern. Males without spear and with degenerate oesophagus.

Type genus:

Sphaeronema Raski & Sher, 1952

Other genus:

Ironphoneme Raski, 1957

KEY TO GENERA OF SPHAERONEMATINAE

Females subspherical ..... Sphaeronema
Females elongate, obese ..... Ironphoneme

FAMILY TYLENCHULIDAE THORNE, 1949 (RASKI, 1962)

Diagnosis: Tylenchuloidea. Females generally small, cylindrical vermiform. Mature females in some forms may become obese and sedentary. Body annules fine rounded, not retrorse. Procorpus

broad. Spear long (often over 20 um), basal knobs sphaeroid. Lateral fields usually present. Vulva in posterior part of body. Males with short, sub-spherical tail. Spear absent, or reduced, if present. Bursa usually absent.

Type and only subfamily:

Paratylenchinae Thorne, 1949

SUBFAMILY PARATYLENCHINAE THORNE, 1949

Diagnosis: Paratylenchidae. Body in both sexes very small, usually less than 0.5 mm in length. Mature females may be elongate cylindrical to plump, or obese and sedentry. Oesophagus with slender isthmus and well developed basal bulb.

Type genus:

Paratylenchus Micoletzky, 1922

Other genera:

Paratylenchoides Raski, 1973

Saccopeurus Thorne, 1943

Gracilacus Raski, 1962

KEY TO GENERA OF PARATYLENCHINAE

1. Lip region sclerotization strongly developed, less so on males ..... Paratylenchoides

   Lip region sclerotization lightly developed 2

2. Females obese, with cuticular ornamentations and very short, blunt tail ..... Cacopaurus

   Females slender to plump or obese, without cuticular ornamentations, tail short and conical to elongate 3

3. Females spear 30 um or less; excretory pore always near nerve ring or posterior to it; females slender ..... Paratylenchus

   Females spear 40 um or more; excretory pore typically anterior to nerve ring, females may be plump to obese ..... Criconemoides

DESCRIPTION OF SPECIES OF CRICONEMATINA

In the following part of the work descriptions of known and new species have been provided. For already known species the dimensions of the body along with the total number of annules on the female (R), annules from vulva to tail tip (RV), from anus to tail tip (Ran), between vulva and anus (RVan), in the region of spear (Rat), oesophagus (R oeso) and from the anterior extremity to excretory pore (Rex) have been given. The habitat(s), locality(ies) and remarks, if any, have also been provided. New species are described in as much detail as possible. All the known and new species are appropriately illustrated. Fifteen genera are involved in the present work and some discussion on each has been given. Each genus forms a separate chapter of the thesis which includes its diagnosis, some remarks, and an up-to-date list of species. First the known species are described, followed by the descriptions of new species. After species descriptions, a key to species of the genus occurring in this country has been given. The new species are compared with closely related species of that genus. The following genera and their species were recorded: Criconema, Neolobocriconema, Hoplocriconema, Ogma, Seriospinula, Macroposthonia, Criconemella, Discocriconemella, Xenocriconemella, Hemicriconemoides, Hemicycliophora, Auleorhora, Calcaisia, Paratylenchus and Cracilacus.

GENUS *Crossonema* MEHTA & RASKI, 1971

The genus was proposed by Mehta & Raski in 1971 for those species of *Criconema* which possess a continuous fringe of spines or scale-like appendages on the annules. They also proposed two subgenera (*Crossonema* and *Seriospinula*) under *Crossonema* and described a new species of this genus. Khan *et al.* (1976) raised the subgenus *Seriospinula* to generic level. Andrássy (1979) considered both *Crossonema* and *Seriospinula* as independent genera and also described one new species of *Crossonema* and two of *Seriospinula*. At present, 13 species of this genus are known from the world and of these *C. fimbriatum*, *C. fimicivatum*, *C. multiscutatum*, *C. taylorium* and *C. taylori* occur in this country. The diagnosis of the genus and a list of nominal species is as follows:

Diagnosis: Criconematinae. Body of female straight or slightly curved ventrally. Lip region with two or three distinctly set off annules, first annule usually wider than second. Body cuticle marked with a continuous fringe of fine spines or blunt rectangular scales arranged in continuous horizontal rows. Submedian lobes absent.

Type species:

Crossonema civellae (Steiner, 1949) Mehta & Raski, 1971

Other species:

C. obtusa Andrássy, 1979

C. aquitaniae (Fiec, 1968) Mehta & Raski, 1971

C. bentleyi (Meyl, 1954) Andrássy, 1979

C. euryaema Golden & Friedman, 1964

C. fimbriatum (Cobb in Taylor, 1936) Mehta & Raski, 1971

C. fimcivatum Khan, Chawla & Saha, 1976

C. latens Mehta & Raski, 1971

C. menzeli (Stefanski, 1924) Mehta & Raski, 1971

C. multiannulatum (Kirjanova, 1948) Mehta & Raski, 1971

C. orcoliva (Hoffmann, 1973) Andrássy, 1979

C. taylorum Khan, Chawla & Saha, 1976

C. taylori (Jairajpuri, 1964) Mehta & Raski, 1971

C. raskii n. sp.

In the soil samples collected during the course of present investigations, 4 species of Crossonema were found. One of these species is new and has been named Crossonema raskii n.sp. and described in detail. The known species are as follows: C. euryaema, C. fimbriatum, C. fimcivatum and C. multiannulatum. Specimen of C. euryaema obtained through the courtesy of Dr. A. Morgan Golden has also been described briefly.

CRICONEMA EURYSOMA GOLDEN & FRIEDMAN, 1964
(Fig. 1, B-G)

Dimensions:

Female: L = 0.37 mm; a = 5.6; b = 4.2; c = 19.8; V = 90; VL/VB = 0.9; total body annules = 41; RV = 5; Ren = 3 ; RVen = 2 ; Rst = 8; Roeso = 11; Rex = ? ; spear = 66 um; metenchium = 56 um.

Habitat and locality: Soil around roots of Citrus grandis from Bettsville, Md. Coll: C.W. Chamblise, July 31, 1945.

Remarks: Mehta & Raski (1971) in their revision of Criconema synonymised C. curvasoma (Golden & Friedman, 1964) Mehta & Raski, 1971 with C. civellae but Andrássy (1979) synonymised it with C. multiannulatum. However, C. curvasoma differs from both these species in having lesser body annules, shorter spear and lesser spines in fringe on each annule.

CRICONEMA FIMBRIATUM (COBB in TAYLOR, 1936) MEHTA & RASKI, 1971
(Fig. 2)

Dimensions:

Females (3): L = 0.49-0.55 mm (0.53 mm); a = 8-10 (9); b = 3.9-4.3 (4.1); c = ? ; V = 86-87 (87); VL/VB = 1.5-1.8 (1.6); total body annules = 55-61 (57); RV = 10-11 (10); Ren = 7 (n = 1); RVen = 3 (n = 1) Rst = 12-13 (12); Roeso = 15-16 (15); Rex = ? ; spear = 96-99 um (98 um);

metenchium = 77-79 um (78 um).

Habitat and locality: Soil around roots of wild plants and grasses near Bhiunder village, Govindaghat, Chamoli, Uttar Pradesh.

Remarks: Criconema fimbriatum was collected from an altitude of 2000 m and the specimens conform well with those described by Mehta & Raski (1971). It is being recorded for the first time from this country.

CRICONEMA FIMCIVATUM KHAN, CHAWLA & SAHA, 1976

(Fig. 3 & 4)

Dimensions:

i) Bee. Nainital, Uttar Pradesh population:

Females (10): L = 0.43-0.51 mm (0.48 mm); a = 7-10 (9); b = 3.4-4.2 (3.7); c = 13-22 (17); V = 89-92(90); VL/VB = 1.0-1.4 (1.1); total body annules = 42-48 (45); RV = 7-8 (7); Ran = 3-6 (4); RVan = 2-5 (3); Rst = 8-10 (9); Roeso = 11-14 (12); Rex = 18 (n = 1); spear = 75-91 um (83 um); metenchium = 62-72 um.

Juveniles (11): L = 0.24-0.33 mm (0.31 mm); a = 6-9 (7); b = 2.1-2.8 (2.5); c = 12 (n = 1); total body annules = 52-56 (53); Rst = 15-18 (16); Roeso = 20-24 (22); Rex = ? ; spear = 71-78 um (76 um); metenchium = 60-69 um.

ii) Pear, Shamkhali, Nainital, Utter Pradesh population:

Females (5): L = 0.49-0.63 mm (0.55 mm); a = 7-11 (9); b = 3.6-4.7 (4.4); c = 17-23 (19); V = 90-93 (91); VL/VB = 0.9-1.2 (1.0); total body annules = 42-52 (49); RV = 6-7 (7); Ran = 3-5 (4); RVan = 2-3 (2); Rst = 8-9 (9); Roeso = 11-13 (11); Rex = ? ; spear = 82-98 um (89 um); metenchium = 70-84 um.

Habitats and localities: Soil around roots of i) pea, Pisum sativum from fields in Bhawali, Nainital, Utter Pradesh; ii) pear, Pyrus communis from Shamkhali, Nainital, Utter Pradesh.

Remarks: Specimens of Crossonema fimcivatum were collected from an altitude of more than 1000 m. Juveniles look entirely different from the adults and have more annules on the body and a differently shaped cuticular configuration. They show similarities with the type population except that the spear may be shorter 75-98 um against 84-105 um in C. fimcivatum Khan et al., 1976.

CROSSONEMA MULTISUNATUM (KIRJANOVA, 1948) MEHTA & RASKI, 1971
(Fig. 1, A-D)

Dimensions:

Females (8): L = 0.36-0.37 mm (0.36 mm); a = 5-6 (6); b = 2.6-2.8 (2.7); c =17 ; V = 90-94 (90); VL/VB = 0.7-0.8 (0.8); total body annules = 44-46 (45); RV = 6-7; Ran = 5; RVan = 1; Rst = 10-12 (11); Roeso = 14-17 (14);

Rex = ? ; spear = 93-94 um (94 um); metenchium = not differentiated.

Habitat and locality: Soil around roots of pear, Pyrus communis from orchards in Bhawali, Nainital, Uttar Pradesh.

Remarks: Crossonema multisquamatum was first described as Cone multisquamatum by Kirjanova (1948). Chitwood (1957) shifted it to the genus Criconema. Mehta & Raski (1971) collected adults of C. civellae and synonymized C. multisquamatum with it. Andrássy (1979) considered C. multisquamatum a valid species. The specimens collected in the present work possess a shorter body (0.34-0.42 mm in C. mulstisquamatum by Andrássy, 1979). This species is being recorded for the first time from India.

CROSSONEMA RASKII N. SP.
(Fig. 5)

Dimensions:

Paratype females (5): L = 0.37-0.50 mm (0.46 mm); a = 8.5-12.3 (9.9); b = 3-4 (4); c = ? ; V = 94-95 (94); VL/VB = 0.6-0.7 (0.7); total body annules = 42-49 (46); spear = 75-96 um (88 um).

Holotype female: L = 0.46 mm; a = 9.8; b = 3.9; c = ? ; V = 94; VL/VB = 0.6; total body annules = 48; spear = 75 um.

Description:

Body almost straight, only slightly ventrally curved upon fixation, cylindrical, tapering a little towards extremities. Body annules thick, 9-11 um apart at midbody, 14-16 annules in oesophageal region, 25-29 annules from oesophago-intestinal junction to vulva and 4 or 5 annules from vulva to tail tip. Body annules marked with 22-28 scales at midbody, decreasing towards extremities. Scales spatula-shaped becoming irregular behind vulva, elongated and bifurcate at tips. A cross-section through midbody (Fig. 5, E) shows four clefts which divide the scales in four groups; these grooves were also observed in lateral view (Fig. 6, F). Lip region dome-shaped, 11-12 um high, set off, marked with two non-retrorse annules, first annule with its margins forward and outwardly directed, 20-25 um; second annule, 17-18 um wide. The first body annule is 21-30 um wide, retrorse. Cephal framework moderately developed. Metenchium 65-78 um or 76-78% of spear length. Basal knobs of spear 10-11 um across, located on 10-14 annule from anterior extremity. Procorpus 18-22 um wide and basal bulb 9-12 um wide at their widest. Nerve ring 122-130 um and oesophago-intestinal junction 117-153 um from anterior extremity. Excretory pore and hemizonid not observed. Vulva located on 4 or 5th annule from posterior extremity. Anus obscure due to broomy nature of scales in that region. Posterior extremity bluntly rounded.

Male: Not found.

Type habitat and locality: Soil around roots of wild bushes from Mukkali, Palapurum, Kerala.

Type specimens: Collected in September 1980. Holotype on slide ST/45 Crossonema raskii n. sp./1; paratype females on slides ST/45 Crossonema raskii n. sp./2-8.

Differential diagnosis: Crossonema raskii n. sp. comes close to C. latens (Mehta & Raski, 1971) Khan et al., 1976 and C. taylatum Khan et al., 1976. From C. latens it differs in having a narrower body, lesser annules on body, behind vulva, more prominent scales behind vulva and in the presence of longitudinal grooves running the entire length of body (a = 7; R = 56-57; RV = 7; scales behind vulva not so prominent and longitudinal grooves absent in C. latens). From C. taylatum it differs in having a smaller and narrower body, lesser distance between striae at midbody, lesser scales in fringe on annules at midbody, in the presence of longitudinal groove and in more posteriorly located vulva (L = 0.51-0.61 mm; a = 5-8; annules 13 um apart at midbody; scales = 30-40 at midbody; longitudinal grooves absent and V = 89-91 in C. taylatum).

The new species has been named in honour of Professor D. J. Raski of the University of California, Davis, U.S.A., who visited this laboratory during February 1979 and with whom I had very useful discussions on the Criconematid nematodes.

KEY TO INDIAN SPECIES OF *CRASSARIUS*

1. Annules bearing less than 40 scale-like projections at mid-body 2
   Annules bearing more than 100 spine-like projections at mid-body ..... *fimgivatum*

2. Body annules 53–58; only four submedian lobes present, laterals absent ..... *taylori*
   Body annules 45–52; four submedian and two lateral lobes present 3

3. Body length = 0.37–0.50 mm; scales = 24–28 on each annule at midbody; V = 94–95; annules interrupted by 4 longitudinal grooves on entire body ..... *raskii* n. sp.
   Body length = 0.51–0.61 mm; scales = 30–40 on each annule at midbody; V = 89–91; annules not interrupted by longitudinal grooves ..... *taylatum*

GENUS NEOLOBOCRICONEMA MEHTA & RASKI, 1971

De Grisse & Loof (1965), while reviewing the genus Criconemoides, proposed five new genera, the genus Lobocriconema was one of them. Under this genus, they included those species of Criconemoides (sensu lato) which possess four submedian lobes. This was evident from the generic name (Greek λοβος = ear-lobe). Mehta & Raski (1971) proposed a new genus, Neolobocriconema for the placement of two of the species of Lobocriconema, viz., L. lateralis (Khan & Siddiqi, 1963) De Grisse & Loof, 1965 and L. serratum (Khan & Siddiqi, 1963) De Grisse & Loof, 1965, because of the characteristic markings on their body annules. Andrássy (1979) synonymized Lobocriconema with Nothocriconema and transferred Lobocriconema aberrans to Neolobocriconema and also described a new species of this genus. At present, there are in all five species under Neolobocriconema. Of these, three species occur in India, viz., Neolobocriconema aberrans, N. lateralis and N. serratum.

During the present study some samples collected from the hills contained three species of Neolobocriconema. One of these is N. aberrans, while the other two are new species.

Diagnosis: Criconematinae. Body robust, 0.34–0.75 mm long, marked with few annules numbering 36–52. Annules are broad with sloping margins and fine striae on them. These are either finely

or heavily serrate or fringed on whole body, or irregularly lobed at the posterior end. Lip region made up of one annule, the second from anterior or first body annule is collar-like or posteriorly retrorse. Submedian lobes present. Vulva closed. Males with four incisures, bursa rudimentary, if present.

Type species:

Neoliboriconema lateralis (Khan & Siddiqi, 1963) Mehta & Raski, 1971

Other species:

N. aberrans (Jairajpuri & Siddiqi, 1963) Andrássy, 1979

N. cataracticum Andrássy, 1979

N. insulicum Choi & Geraert, 1975

N. serratum (Khan & Siddiqi, 1963) Mehta & Raski, 1971

N. breviatylum n. sp.

N. neoaberrans n. sp.

NEOLIBORICONEMA ABERRANS (JAIRAJPURI & SIDDIQI, 1963) ANDRÁSSY, 1979

(Fig. 6)

Dimensions:

1) Ayole, Nainital, Uttar Pradesh population:

Females (24): L = 0.38-0.58 (0.43 mm); a = 7-10(8); b = 3.2-4.7 (4.3); c = 13-20 (13); V = 81-94 (92); VL/VB = 0.7-1.3 (1.0); total body annules = 40-48 (42); RV = 4; Ran = 3; RVan = 1; Rst = 9-10 (9); Roeso = 11-14 (13); Rex =

10-11 (10); spear = 61-79 um (68 um); metenchium = 54-67 um.

ii) Pear, Nainital, Uttar Pradesh population:

Females (5): L = 0.45-0.58 mm (0.53 mm); a = 8-10 (9); b = 4.0-4.7 (4.5); c = 9-17 (13); V = 89-92 (89); VL/VB = 0.9-1.3 (1.1); total body annules = 40-43 (42); RV = 5; Ran = 4; RVan = 1; Rst = 7-9 (8); Rosso = 10-12 (11); Rex = ? ; spear = 61- 7 um (64 um); metenchium = 55-61 um.

iii) Peach, Nainital, Uttar Pradesh population:

Females (5): L = 0.49-0.58 mm (0.56 mm); a = 8-10 (9); b = 4.1-4.3 (4.2); c = 11-16 (14); V = 89-90(90); VL/VB = 1.0-1.4 (1.2); total body annules = 40-41 (40); RV = 4-5; Ran = 3-4(3); RVan = 1; Rst = 9-10 (8); Rosso = 12-13 (12); Rex = ? ; spear = 73-79 um (75 um); metenchium = 61-67 um.

iv) Wild grasses, Chamoli, Uttar Pradesh population:

Females (5): L = 0.45-0.46 mm (0.45 mm); a = 8.2-8.6 (8.4); b = 4; c = 11 (n = 1); V = 91-92 (91); VL/VB = 1.0-1.2 (1.0); total body annules = 40-45 (43); RV = 5-6 (6); Ran = 4 (n = 1); RVan = 2; Rst = 8-9 (8); Rosso = 11-12 (11); Rex = 13 (n = 1); spear = 65-70 um (68 um), metenchium = 49-54 um.

Habitats and localities: Soil around roots of i) apple, Malus pumila from Ramgarh, Nainital, Uttar Pradesh; ii) pear,

Pyrus communis from Ramgarh, Nainital, Uttar Pradesh; iii) peach, Prunus persica from Bhawali, Nainital, Uttar Pradesh; iv) wildgrasses from Pulna village, Chamoli, Utter Pradesh.

Remarks: Neoloboericonema aberrans was described by Jairajpuri & Siddiqi (1963) as Cricenemoides aberrans which was later transferred to Neoloboericonema by Andrássy, 1979. The present populations of this species are similar to the type population.

NEOLOBOCRICONEMA BREVISTYLUM N. SP.
(Fig. 7)

Dimensions:

Paratype females (4): L = 0.34-0.41 mm (0.38 mm); a = 8.2-9.3 (9.1); b = 3.3-4.2 (3.8); c = ? ; V = 93; VL/VB = 0.7-0.9 (0.8); total body annules = 45-52 (48); spear = 45-47 um (46 um).

Holotype female: L = 0.34 mm; a = 8.2; b = 3.9; c = 7; V = 93; VL/VB = 0.8; total body annules=47; spear = 47.

Description:

Body ventrally curved upon fixation, tapering towards extremities. Body annules 6-7 um apart at midbody, 12-15 annules

in oeso hageal region, 25-32 annules from oesophago-intestinal junction to vulva and 4-5 annules from vulva to tail tip. Annul s slightly wavey or crenate on whole body, more on tail region, anastomoses of annul s rare. Lip region hat-like, set off and marked with one annule, 19-21 um wide. The first body annule 21-25 um and second annule 24-27 um wide. Labial sclerotization weakly developed, labial plates extending up to the base of first body annule. En face view showing four submedian lobes and two lateral elongate pseudolips bearing amphidial apertures; labial disc oval bearing oral aperture. Metanchium 32 um long or 69% of spear length. Basal knobs of spear wall developed 8-9 um across, located on 7-10th annule from anterior extremity. Orifice of dorsal oesophageal gland 3 um apart from spear base. Prometacorpus 18-19 um wide and basal bulb 10-11 um wide at their widest. Nerve ring 79-85 um and oesophago-intestinal junction 87-100 um from anterior extremity. Excretory pore located on 18th annule from anterior extremity. Hemizonid obscure. Spermatheca present, oval. Vulva with lips, located on 4th or 5th annule from posterior extremity. Anus not seen. Tail end bluntly conoid, with 2 or 3 finger-like lobes.

Male : Not found.

Type habitat and locality: Soil around roots of wild trees from Chamundi hills, near bus stop, Mysore, Karnataka.

Type specimens: Collected in September 1980. Holotype on slide SP/21 Neolobocricconema breviatylum n. sp./1; paratype females on slides Neolobocriconema breviatylum n. sp./2.

Differential diagnosis: Neolobocricconema breviatylum n. sp. differs from the other species of the genus in having the smallest spear. However, it comes close to N. aberrans from which it differs in having a smaller body but more body annules (L = 0.45-0.54 mm; R = 38-43 in N. aberrans).

NEOLOBOCRICONEMA NEOABERRANS N. SP.
(Fig. 8)

Dimensions:

Paratype female: L = 0.68 mm; a = 10; b = 4.4; c = 7; V = 92; VL/VB = 1.1; total body annules = 33; spear = 102 um.

Holotype female: L = 0.67 mm; a = 9.7; b = 4.5; c = 41; V = 92; VL/VB = 1.1; total body annules = 32; spear = 106 um.

Description:

Body almost straight upon fixation, tapering very slightly towards extremities. Body annules 21-or 22 um apart at midbody, 8 or 9 annules in oesophageal region, 20 annules from oesophago-intestinal junction to vulva, one annule from vulva to anus and 3 annules from anus to tail tip. Body annules retrorse, bearing fine fringe of short lobes or appendages,

70-80 on each annule at midbody, longitudinal markings also present on annules. First few annules only wavy, the last two annules on tail becoming irregular and provided with lobes which have trifid appendages. Terminal annule bearing 3-5 finger-like lobules. Lip region with its first annule dome-shaped, 19-20 um high and 40 um wide bearing submedian lobes. First body annule 36-38 um wide and second body annule 48-52 um wide. Metanchium 79-83 um long or 77-78% of spear length. Basal knobs of spear 14-15 um across, located on 7th annule from anterior extremity. Rhabdions 26-27 um and basal bulb 11-12 um wide at their widest. Nerve ring 140-165 um, oesophago-intestinal junction 150-155 from anterior extremity. Excretory pore located on 13th annule from anterior extremity. Hemizonid not observed. Vulva conical, located on 3rd or 4th annule and anus on 2nd or 3rd annule from posterior extremity. Vulva-anus only one annule apart, their distance nearly one-fourth of vulval body-width. Tail conoid, one anal body-width or three times of vulva-anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of wild plants from Meerganj, Shikohabad, Saharanpur, Uttar Pradesh.

Type specimens: Collected in September 1979. Holotype on slide CH/7 Leptocriconema neoborrense n. sp./1; paratype female on slide CH/7 Leptocriconema neoborrense n. sp./2.

Differential diagnosis: Boleboecricnema neoaberrans n. sp. differs from all the other species of the genus in having lesser number of body annules. However, it comes close to B. aberrans (Vairaprasuri & Siddiqi, 1963) Andrássy, 1979 and B. cataracticum Andrássy, 1979. From B. aberrans it differs in general body appearance, in having a longer body, in the presence of continuous fringe of lobes on annules and a longer spear (L = 0.45-0.54 mm; only slightly crenate annules and spear 60-78 um long in B. aberrans). From B. cataracticum it differs in having a longer body; in the shape of lip annule and in having a smaller number of fringes or lobes on the annules (L = 0.34-0.44 mm; lip annule saucer-shaped; lobes 120-150 on each annule in B. cataracticum).

KEY TO THE SPECIES OF BOLBOECRICNEMA

1. Spear 45-78 um long, annules on tail with loboid scales.... 4

   Spear 90-122 um long, annules on tail without loboid scales 2

2. Cuticular appendages form fringed ring around each annule, not interrupted by longitudinal grooves on lateral sides 3

   Cuticular appendages form fringed ring around each annule, interrupted by longitudinal grooves on lateral sides .... lateralis

3. Margins of the annules moderately serrate, without pronounced elongations on tail region; R = 36–38; spear 90–96 um long .. .. serratum

   Margins of the annules deeply serrate, with pronounced elongationson tail region; R = 33; spear 102–106 um long .... neoberrmea n. sp.

4. Spear 60–78 um long ..... spearens

   Spear 45–47 um long ..... brevistylus n. sp.

GENUS NOTHOCRICONEMA DE GRISSE & LOOF, 1965

De Grisse & Loof (1965) proposed the genus Nothocriconema. Farjan (1966), Raski & Golden (1966) and Luc (1970) regarded the genus as a synonym of Criconemoides Taylor, 1936. Andrássy(1979) has recognized it as a valid genus and listed 35 species under it. Another species N. decrissei was described by Bagri (1979) from West Bengal, India. At present, there are 36 species under this genus and of these 7 species are found in India, viz., N. acriculum, N. cardamomi, N. corbetti, N. decrissei, N. jaejuense, N. kevecai and N. mukevum. During the present study soil samples collected from the high altitude [illegible]d several populations of this genus. Close examination revealed that these populations represent three new species. The other populations represent already known species, 3 of which are being recorded for the first time, viz., N. acriculum, N. corbetti, N. jaejuense. The species of Nothocriconema perhaps do not exhibit host-specificity because populations of N. acriculum, N. corbetti, N. jaejuense, N. kevecai etc., were collected from different host plants.

Diagnosis: Criconematinae. Body small to rather large (0.24-0.74 mm), annules smooth, only exceptionally finely crenate on the posterior margins towards posterior extremity of body, very rarely lobed or fringed; outline of annules rounded. Lip region consisting of one or two annules, first

annule often hat-like and usually wider than second. Submedian lobes hardly developed or absent. Vulva with big anterior lip. Juvenile cuticle with ornamentations, scale-like or mostly pointed appendages arranged in 8-24 longitudinal rows. Males rare with 3-4 setoral lines. Bursa rudimentary. Tail of female mostly conoid to pointed, sometimes bluntly rounded.

Type species:

Lothocricconema annuliferum (De Man, 1921) De Grisse & Loof, 1965

Other species:

L. acriculum Raski & Pinochet, 1976

L. arcanum (Raski & Golden, 1966) De Grisse, 1967

L. brevicaudatum (Siddiqi, 1961) Andrássy, 1979

L. calyum (Raski & Golden, 1966) De Grisse, 1967

L. cardamomi Khan & Nanjappa, 1973

L. corbetti De Grisse, 1967

L. crassiannulatum (De Guiran, 1963) Andrássy, 1979

L. crotaloides (Cobb, 1924) De Grisse & Loof, 1965

L. demani (Micoletzky, 1925) De Grisse & Loof, 1965

L. decrianei Baqri, 1979

L. dubium De Grisse, 1967

L. duplicivestitum (Andrássy, 1963) De Grisse & Loof, 1965

L. jaejuense Choi & Geraert, 1975

L. kovacsi (Andrássy, 1963) De Grisse & Loof, 1967

L. lamellatum (Raski & Golden, 1966) De Grisse, 1967

L. *acanthum* (Cunhold, 1953) De Grisse & Loof, 1965

L. *loofi* De Grisse, 1967

L. *oscilentum* Raski & Pinochet, 1976

L. *mukerjum* Khan, Chawla & Saha, 1976

L. *mutabile* (Taylor, 1936) De Grisse & Loof, 1965

L. *orientale* Andrássy, 1979

L. *pacificum* (Andrássy, 1965) Andrássy, 1967

L. *paraguayense* Andrássy, 1968

L. *paticum* Raski & Pinochet, 1976

L. *pauperum* (De Grisse, 1967) Andrássy, 1979

L. *permistum* (Raski & Golden, 1966) De Grisse, 1967

L. *petasum* (Wu, 1965) De Grisse & Loof, 1965

L. *princeps* (Andrássy, 1962) De Grisse & Loof, 1965

L. *psammophilum* Krnjaic & Loof, 1973

L. *racum* (Boonduang & Ratanaprapa, 1974) Andrássy, 1979

L. *sabiense* (Heyns, 1970) Andrássy, 1979

L. *salitarium* De Grisse, 1967

L. *sphaeni* (Micoletzky, 1925) De Grisse & Loof, 1965

L. *spinicaudatum* Raski & Pinochet, 1976

L. *victoriae* Heyns, 1970

L. *vortulatum* n. sp.

L. *shamsii* n. sp.

L. *himalicum* n. sp.

In the present work 3 new species of *Lothocricconema* and 5 already known species are described. Three of the known

species are being recorded for the first time from India. Males were not found in any of the species.

MOTYLOCRICONEMA ACRICULUM RASKI & PINOCHET,1976
(Fig. 9, C-I)

Dimensions:

Females (7): L = 0.31-0.40 mm (0.36 mm); a = 11-12(11); b = 3.5-4.1 (3.6); c = 11.5; V = 82-84 (83); VL/VB = 1.8-2.2 (2.0); total body annules = 86-92 (90); RV = 15-16(16); Ran = 7-8 (7); RVan = 7-8 (8); Rat = 17-19 (18); R oeso = 22-25 (24); Rex = 25 or 26; spear = 55-58 um (57 um); metenchium = 43-46 um.

Habitats and localities:

Soil around roots of i) peach, Prunus persica from Ramgarh, Nainital, Uttar Pradesh; ii) wild plants, from Rishikesh, Saharanpur, Uttar Pradesh.

Remarks: The dimensions are in general agreement with those described by Raski & Pinochet (1976) from Africa. It is the first record of the species from this country.

NOTHOCRICONEMA CORBETTI DE GRISSE, 1967
(Fig. 9, D-F)

Dimensions:

Females (5): L = 0.38-0.39 mm (0.38 mm); a = 9.8-10.0 (9.9); b = 4.0-4.5 (4.0); c = 19.7; V = 92-94(93); VL/VB = 0.8-1.0 (0.9); total body annules = 65-69 (67); RV = 6-7 (7); Ran = 4-5 (5); RVan = 2; Rst = 10; R oeso = 16-17(16); Rex = 21 (n = 1); spear = 51-53 um (52 um); metenchium = 38-40 um.

Habitats and localities: Soil around roots of i) wild trees from Silent Valley, Malapurum, Kerala; ii) Eucalyptus sp. from Mukkali, Malapurum, Kerala.

Remarks: Nothocriconema corbetti was described by De Grisse(1967) from Africa. Luc (1970) transferred it to the genus Criconemoides. Andrássy (1979) again brought it to Nothocriconema. The present samples which yielded this species were from an altitude of more than 2000 m. This also is incidently the first record of the species from India. The Indian specimens resemble the type in most of the dimensions and morphological details.

[illegible] CHOI & GERAERT, 1975
(Fig. 10, A–E)

Dimensions:

Females (3): L = 0.48–0.53 mm; a = 10–11; b = 3.9–4.1; c = 15.9–22.0; V = 89–90; VL/VB = 1.3–1.5; total body annules = 52–58; RV = 9–10; Ran = 6–7; RVan = 3; Rst = 10–11; R oesc = 15–16; Rex = ? ; spear = 75–76 um; metenchium = 60–61 um.

Habitat and locality: Soil around roots of grasses near waterfall, Chancharia, Chamoli, Uttar Pradesh.

Remarks: This species was originally described from Korea by Choi & Geraert (1975). The present specimens conform well with the type except that they have a slightly smaller spear (80–85 um in *A. jejuensis* by Choi & Geraert, 1975). These specimens were collected from an altitude of over 3000 m and represent the first record from India.

[illegible] ELVACSI (ANDRÁSSY, 1963) DE GRISSE & LOOF, 1965
(Fig. 9, A–C)

Dimensions:

Females (12): L = 0.29–0.36 mm (0.33 mm); a = 11–13 (12); b = 3.3–4.2 (3.8); c = 14–21 (18); V = 89–90(90); VL/VB = 1.3–1.5 (1.3); total body annules = 94–114 (110); RV = 11–13 (12); Ran = 7–10 (9); RVan = 3–5 (4); Rst =

18-20 (20); R o.so = 27-31 (29); Rex = 30-32; spear = 56-64 um (62 um), metenchium = 48-52 um.

Habitats and localities: Soil around roots of i) peach, Prunus persica from Shamkhali village, Bhowali, Nainital, Uttar Pradesh; ii) peach, Prunus persica from Sahastradhara, Dehradun, Uttar Pradesh; iii) apricot, Prunus armeniaca from Claimant town, Dehradun, Uttar Pradesh.

Remarks: Nothocriconema kovacsi is a widely distributed species. Andrássy (1963) described it as Criconemoides kovacsi. De Grisse & Loof (1965) shifted it to Nothocriconema. Present specimens do not exhibit any differences from those originally described by Andrássy (1963).

NOTHOCRICONEMA MURUVUM KHAN, CHAWLA & SAHA, 1976
(Fig. 10, F-J)

Dimensions:

Females (6): L = 0.32-0.38 mm (0.35 mm); a = 11-12(12); b = 4.1-4.9 (4.5); c = 19.4-25.5 (23.2); V = 90-92 (91); VL/VB = 1.2-1.3 (1.2); total body annules = 106-116 (111); RV = 11-12 (11); Ran = 7-8 (8); RVan = 3.5 (4); Rat = 16-17 (16); R oeso = 24-26 (25); Rex = 28-31 (29); spear = 46-48 um (47 um); metenchium = 38-41 um.

Habitat and locality: Soil around roots of peach, Prunus persica from Srinagar, Jammu & Kashmir.

Remarks: This species was described from Almora, Uttar Pradesh, but the present specimens come from Srinagar. These have more annules behind vulva (AV = 7-8 in *M. mukeyum* according to Khan *et al.*, 1976).

MONHYSTERIUM CORNUTUM N. Sp.
(Fig. 11)

Dimensions:

Paratype females (5): L = 0.40-0.49 mm (0.45 mm); a = 8-9 (8); b = 3.7-3.9 (3.8); c = 29.7-47.2 (36.9); V = 95-96 (96); VL/VB = 0.4-0.6 (0.6); total body annules = 66-73 (71); spear = 62-66 um (65 um).

Holotype female: L = 0.42 mm; a = 8; b = 3.9; c = 40.4; V = 96; VL/VB = 0.4; total body annules = 68; spear = 62 um;

Description:

Slightly ventrally curved upon fixation, cylindrical, tapering slightly towards extremities. Body annules 4-5 um apart at midbody, 18-19 annules in oesophageal region, 46-52 annules from oesophago-intestinal junction to vulva, one annule between vulva and anus, and 2 or 3 annules from anus to tail tip. Body annules retrorse with posterior margins heavily crenate, annules with break of transverse striae. Lip region 70 um high set off, marked with two non-retrorse annules, first annule rounded with its margins directed laterally,

15-22 um wide, second annule collar-like, 17-30 um wide. The first body annules, retrorse 20-32 um wide. Labial framework weakly sclerotized. Metenchium 48-52 um or 78-79% of spear length. Basal knobs of spear 9-10 um across, located on 13th annule from anterior extremity. Orifice of dorsal oesophageal gland 4 um from spear base. Prometacorpus 13-15 um wide and basal bulb 10-11 um wide at their widest. Nerve ring 87 um, oesophago-intestinal junction 106-130 um from anterior extremity. Excretory pore located on 21st and hemizonid on 20th annule from anterior extremity. Spermatheca non-functional. Vulva located on 3rd or 4th annule and anus on 2nd or 3rd annule from posterior extremity. Vulva-anus one annule apart, their distance about one-sixth of vulval body-width. Tail bluntly rounded, nearly half of anal body-width or five times of vulva-anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of peach, Prunus persica and apricot, Prunus armeniaca from Company gardens, Saharanpur, Uttar Pradesh.

Type specimens: Collected in March 1978. Holotype on slide CRP/100 Lethocirconema corbulatum n. sp./1; peratype females on slides CRP/100 Lethocriconema corbulatum n. sp./2-8.

Differential diagnosis: Lethocriconema corbulatum n. sp. comes

close to N. crassiannulatum (De Guiran, 1963) Andrássy, 1979, N. corbetti De Grisse, 1967 and N. victoriae Heyns, 1970. From N. crassiannulatum it differs in having a longer body, more annules on body, lesser annules behind vulva, in the presence of break in striae of annules and in the posterior location of vulva (L = 0.32-0.35 mm; R = 33-43; RV = 4-7; break in striae on annules absent and V = 91-94 in N. crassiannulatum). From N. corbetti it differs in having crenation on the posterior margins of annules, lesser annules behind vulva, a longer spear, more posteriorly located vulva and in the shape of tail (annule margins smooth except behind vulva; RV = 6-7; spear = 45-58 um; V = 92-94 and tail conoid in N. corbetti). From N. victoriae it differs in having a longer body, more annules on body, first lip annule smaller than second, a longer spear and more posteriorly located vulva (L = 0.31-0.40 mm; R = 61-66; first lip annule bigger than second; spear = 50-53 um and V = 88-90 in N. victoriae).

MACROCRICONEMA CHAMOLLI N. SP.
(Fig. 12)

Dimensions:

Paratype females (4): L = 0.71-0.85 mm (0.76 mm); a = 12-14 (13); b = 4.5 -5.8 (5.1); c = 10-11 (11); V = 84-87 (86); VL/VB = 1.8-2.5 (2.2); total body annules = 58-64 (62); spear = 92-99 um (96 um).

Holotype female: L = 0.85 mm; a = 14; b = 5.8; c = 11; V = 85; VL/VB = 2.2; total body annules = 60; spear = 99 um.

Description:

Body almost straight upon fixation, cylindrical, tapering a little towards anterior end but more behind vulva. Body annules 11-12 um apart at midbody, 12-15 annules in oesophageal region, 36-40 annules from oesophago-intestinal junction to vulva, 2 or 3 annules from vulva to anus and 7 or 8 annules from anus to tail tip. Body annules rounded with their posterior margins crenate or wavey. A few breaks in striae on annules present. Lip region 10-12 um high, marked with two non-retrorse annules, first annule 26-29 um wide, second annule 27-32 um wide. The first body annule 31-35 um wide and retrorsed. Labial framework weakly developed. Metanchium 71-75 um or 77-78% of spear length. Basal knobs of spear 12 um across, located on 9 or 10th annule from anterior extremity. Orifice of dorsal oesophageal gland 9-10 um from spear base. Prometacorpus 21-24 um wide and basal bulb 12-17 um wide at their widest. Nerve ring 125-130 um, oesophago-intestinal junction 150-213 um from anterior extremity. Excretory pore located on 18 or 19th annule from anterior extremity. Vulva simple, located on 10 or 11th annule and anus on 7 or 8th annule from posterior extremity. Vulva-anus 2 or 3 annules apart or distance being more than a vulval body-width. Tail

conoid, two times of anal body-width or nearly two times of vulva-anus distance long. Tail terminus knob-like, last 2 or 3 annules hyaline.

Male: Not found.

Type habitat and locality: Soil around roots of wild plants from Changharia, Chamoli, Uttar Pradesh.

Type specimens: Collected in October 1979. Holotype on slide CH/57 Nothocriconema chamolii n. sp./1; paratype females on slides CH/57 Nothocriconema chamolii n. sp./2,3.

Differential diagnosis: Nothocriconema chamolii n. sp. comes close to N. duplicivestitum (Andrássy, 1963) De Grisse & Loof, 1965, N. loofi De Grisse, 1967 and N. degrissei Baqri, 1970. From N. duplicivestitum it differs in having a longer and narrower body, longer spear, more annules on body behind vulva and more anteriorly located vulva (L = 0.34-0.40 mm; a = 12; spear = 66-72 um; RV = 8-9 and V = 88-90 in N. duplicivestitum). From N. loofi it differs in having a longer and narrower body, lesser annules on body and more anteriorly located vulva (L = 0.51-0.63 mm; a = 11-12; R = 68-75 and V = 87-90 in N. loofi). From N. degrissei it differs in having a longer body, the second lip annule smaller than the first body annule and a longer spear (L = 0.36-0.45 mm; the second lip annule bigger than first body annule and spear = 65-68 um in N. degrissei).

MESOCRICONEMA HIMALICUM n. sp.
(Fig. 13)

Dimensions:

1) Wildplants, Chamoli, Uttar Pradesh population (Type):

Paratype females (6): L = 0.29–0.36 mm (0.32 mm); a = 10–12 (11); b = 3.3–3.8 (3.5); c = 9.9–10.8 (10.2); V = 84–86 (85); VL/VB = 1.5–2.0 (1.7); total body annules = 75–83 (79); spear = 62–64 um (63 um).

Holotype female: L = 0.35 mm; a = 11; b = 3.6; c = 10.2; V = 85; VL/VB = 2.0; total body annules = 81; spear = 63 um.

11) Apricot, Mussoorie, Uttar Pradesh population:

Paratype females (4): L = 0.33–0.36 mm (0.34 mm); a = 9.8–10.7 (10.0); b = 3.7–3.8 (3.7); c = 8.3–8.4 (8.3); V = 81; VL/VB = 1.8; total body annules = 83–85 (85); spear = 61–64 um (63 um).

Description:

Body ventrally curved upon fixation, plump, tapering towards extremities. Body annules 3–4 um apart at midbody, 24–26 annules in oesophageal region, 37–44 annules from oesophago-intestinal junction to vulva, 5 or 6 annules from vulva to anus and 9 or 10 annules from anus to tail tip. Body annules retrorse with posterior margins crenate. Few anastomosing of annules present. Lip region 5–6 um high,

marked with two non-retrorse, rounded annules, first annule 13-14 um wide, second annule 12-13 um wide. The first body annule retrorse, 15-17 um wide. Labial framework weakly sclerotized, submedian lobes in the lip contour only slightly elevated. Metanchium 53-55 um or 86% of spear length. Basal knobs of spear 7-8 um across, located on 17-19th annule from anterior extremity. Orifice of dorsal oesophageal gland 3-4 um from spear base. Prometacorpus 15-17 um and basal bulb 8-11 um wide at their widest. Nerve ring 80-85, oesophago-intestinal junction 90-105 um from anterior extremity. Excretory pore at the level of oesophago-intestinal junction, located on 24 or 25th annule and hemizonid on 23rd annule from anterior extremity. Spermatheca empty, 24 um wide. Vulva located on 14 or 15th annule and anus on 9 or 10th annule from posterior extremity. Vulva-anus 5 or 6 annules apart or the distance between them is nearly two thirds of vulval body-width. Tail elongate-conoid, more than one anal body-width or nearly two times of vulva-anus distance long. Tail terminus with 2 or 3 annules.

Male: Not found.

Type habitat and locality: Soil around roots of wildplants from Mandal, Chamoli, Uttar Pradesh.

Other habitat and locality: Soil around roots of apricot, Prunus armeniaca from Mussoorie, Dehradun, Uttar Pradesh.

Type specimens: Collected in March 1978 and September 1979. Holotype on slide CH/30 Nothocricconema himalicum n. sp./1; paratype females on slides CH/30 Nothocricconema himalicum n. sp./2 & 3; other paratype females on slide CRP/81 Nothocricconema himalicum n. sp./1.

Differential diagnosis: Nothocricconema himalicum n. sp. comes close to N. demani (Micoletzky, 1925) De Grisse & Loof, 1965, and N. loofi De Grisse, 1967. From N. demani it differs in having a smaller body marked with more annules, first lip annule bigger than second, anastomoses of annules present and their posterior margins crenate and in having VL/VB under 2.0 (L = 0.38-0.50 mm; R = 60-75; first lip annule smaller than second; anastomoses of annules absent; posterior margins of annules smooth and VL/VB = over 2.0 in N. demani). From N. loofi it differs in having a smaller body marked with more annules, anastomoses of annules present and their posterior margins crenate, a smaller spear and more anteriorly located vulva (L = 0.51-0.63 mm ; R = 60-75; anastomoses of annules absent; posterior margins of annules smooth; spear = 89-99 um and V = 87-90 in N. loofi).

KEY TO INDIAN SPECIES OF NOTHOCRICONEMA

1. Body length = 0.25-0.62 mm 2

   Body length = 0.71-0.85 mm ..... Chamlii n. sp.

2. Spear 46–66 um long 3
   Spear 100–120 um long ..... cardamomi

3. Annules on body numbering 42–92 4
   Annules on body numbering 94–123 9

4. spear 46–64 um long; R = 58–92 5
   spear 75–76 um long; R = 52–58 ..... jeejeebhoyi

5. Annules behind vulva numbering 3–7 6
   Annules behind vulva numbering 14–16 8

6. Spear 62–66 um long; RV = 3 or 4 ..... corbulatum n. sp.
   Spear 51–56 um long; RV = 5–7 7

7. Body length = 0.36–0.39 mm; spear = 51–53 um long; R = 65–69; RV = 6 or 7 ..... corbetti
   Body length = 0.49 mm; spear = 58 um long; R = 42; RV = 5 ..... brevicaudatum

8. Spear 55–58 um long; R = 86–92 ..... cuticulum
   Spear 61–64 um long; R = 75–85 ..... himalicum n. sp.

9. Spear 52–70 um long; lip region with one annule body annules smooth 10
   Spear 40–48 um long; lip region with two annules; body annules crenate ..... [illegible]

10. Scales on larval cuticle arranged in 15–17 longitudinal rows; RV = 8–12 ..... mutabile
    Scales on larval cuticle arranged in 24 longitudinal rows RV = 12–14 ..... [illegible]

GENUS *Criconema* SOUTHERN, 1914

Southern (1914) proposed the genus *Criconema* for *Criconema murrayi*. Kirjanova (1948) and Sch. Stekhoven & Teunissen (1938) described many more species of *Criconema*. The genus *Criconema* by Hofmänner & Menzel was also proposed in 1914 but a few month earlier than *Criconema*. The latter was therefore considered a synonym of *Criconema* until Andrássy (1979) regarded *Criconema* as *Genus inquirenda* and transferred its species to *Criconema*. So far, 15 species of this genus are known and of these *Criconema coffeae*, *C. fortedari*, *C. octangulare*, *C. rhodium*, *C. similense* and *C. spinosum* are reported from this country.

Nine populations of *Criconema* were collected in this work and all come from the hills. These represent two known and three new species. The known ones are - *Criconema coffeae* and *C. octangulare*. The latter species was collected from many localities from different host plants. The diagnosis of the genus and a list of species is as follows:

Diagnosis: Criconematinae. Body small to moderate (0.27-0.66 mm) straight or slightly ventrally curved. Annules 51-88, bearing scales or rounded or pointed appendages; scales may be wider than longer or vice-versa; arranged in 8-18 longitudinal rows. Lip region marked with two annules, first annule exceptionally wider than the second. Pseudolips with submedian lobes more or less developed. Spear 48-116 um. Vulva conical,

closed, on 5-19th annules from tail tip. Males with lateral fields having 4 incisures. No bursa.

Type species:

Lcma murrayi Southern, 1914

Other species:

L. chrisbernardi (Heyns, 1970) Andrássy, 1979

L. coffeae (Edward, Misra & Rai, 1970) Andrássy, 1979

L. decalineatum (Chitwood, 1957) Andrássy, 1979

L. duodecimtilineatum (Andrássy, 1968) Andrássy, 1979

L. fotedari (Mahajan & Bijral, 1973) Andrássy, 1979

L. lentiforme Sch. Stekhoven & Teunissen, 1938

L. octenculare (Cobb,1914) Sch.Stekhoven & Teunissen, 1938

L. querci (Choi & Geraert, 1975) Andrássy, 1979

L. rhombosquamatum (Mehta & Raski, 1971) Andrássy, 1979

L. rhosinum (Khan, Chawla & Saha, 1976) Andrássy, 1979

L. similemus (Jairajpuri, 1963) Andrássy, 1979

L. spinosum Andrássy, 1979

L. squamiferum (Heyns, 1970) Andrássy, 1979

L. sturnovi Kirjanova, 1948

L. paraoctenculare n. sp.

L. parvum n. sp.

L. upum n. sp.

CGMA COFFEAE (EDWARD, MISRA & RAI, 1970) ANDRÁSSY, 1979
(Fig. 14)

Dimensions:

Females (4): L = 0.31-0.36 mm (0.34 mm); a = 9.5-9.9 (9.5); b = 3.6-3.9 (3.7); c = 8.9-10.9 (9.2); V = 84-86 (85); VL/VB = 1.7-1.8 ((1.7); total body annules = 76-82 (79); RV = 13-14 (14); Ran = 9; RVan = 5; Rst = 15-18 (16); R oeso = 21-23 (22); Rex = 29; spear = 62-69 um (65 um); metenchium = 53-59 um.

Habitat and locality: Soil around roots of grasses and mosses from bank of Ganges, near Lakshman jhula, Rishikesh, Saharanpur, Uttar Pradesh.

Remarks: Edward et al. (1970) described it from soil around roots of coffee plants from Mysore. The present specimens are similar except that the two lip annules are equal.

CGMA CYLINDRICUDATE (COBB, 1914) SCH. STEKHOVEN & TEUNISSEN, 1938
(Fig. 15)

Dimensions:

1) *Jum. Jamaccoria, Uttar Pradesh population:*

Females (4): L = 0.31-0.42 mm (0.38 mm); a = 8-10 (9); b = 3.2-4.2 (4.0); c = 8-17 (13); V = 84-86 (85); VL/VB = 1.4-1.9 (1.8); total body annules = 60-69 (66); RV =

10–12 (12); Ran = 8; RVan = 2–4 (3); Rst = 11–13 (12); R oesо = 15–17 (16); Rex = 7 ; spear = 61–62 um (62 um), metenchium = 45–48 um.

ii) Indian redwood, Lohrasha, Uttar Pradesh population:

Females (2): L = 0.36–0.37 mm; a = 8; b = 3.4–3.9; c = 8–9; V = 84–85; VL/VB = 1.5–1.6; total body annules = 67; RV = 12–13; Ran = 9–10; RVan = 3; Rst = 13–15; R oesо = 15–16; Rex = 7 ; spear = 61–64 um; metenchium = 47–49 um.

iii) Apricot, Almora, Uttar Pradesh population:

Females (5): L = 0.37–0.44 mm (0.41 mm); a = 10–12 (12); b = 3.8–4.6 (3.9); c = 12 (n = 1); V = 84–88 (86); VL/VB = 1.8–2.1 (2.0); total body annules = 70–71 (70); RV = 12–13 (12); Ran = 9 (n = 1); RVan = 3 (n = 1); Rst = 12–14 (14); R oesо = 15–16 (15); Rex = 21 (n = 1); spear = 61–63 um (62 um); metenchium = 46–49 um.

iv) Pinus, Pinetum, Jammu & Kashmir population:

Females (10): L = 0.35–0.45 mm (0.38 mm); a = 8–11 (8); b = 3.6–4.8 (4.2); c = 7–11 (10); V = 81–88 (86); VL/VB = 1.6–2.4 (2.0); total body annules = 59–65 (62); RV = 11–13 (12); Ran = 7–10 (9); RVan = 3–5 (4); Rst = 9–12 (11); R oesо = 16; Rex = 21; spear = 60–62 um (61 um); metenchium = 45–48 um.

v) Pear, Nepal population:

Female : L = 0.38 mm; a = 8; b = 4.2; c = 10; V = 86; VL/VB = 1.6; total body annules = 71; RV = 12; Ran = 9; RVan = 3; Rst = 14; R oeso = 19; Rex = ? ; spear = 63 um; metenchium = 48 um.

Habitats and localities: Soil around roots of i) plum, Prunus communis from plum orchards, Mussoorie, Dehradun, Uttar Pradesh; ii) Indian redwood, Dalbergia sissoo from Raipur, Dehradun, Uttar Pradesh; iii) apricot, Prunus armeniaca from Kairala village, Almora, Uttar Pradesh; iv) pinus, Pinus longifolia from Srinagar, Jammu & Kashmir; v) pear, Pyrus communis from Dhulikhel, Kathmandu, Nepal.

Remarks: Lucs octangulare is one of the commonest species occurring at high altitudes in India. All the samples which yielded this species came from an altitude over 2000 m. The present specimens are similar in all respects to those described by Siddiqi (1961) and Andrássy (1979) except that they have lesser annules on body.

LUCS PARACANCELLATUS n. sp.
(Fig. 16)

Dimensions:

Paratype females (6): L = 0.34–0.36 mm (0.35 mm); a = 8–9 (9); b = 3.8–4.3 (4.1); c = 11.6–14.7 (13.0); V =

84–86 (85); Va/VB = 1.5–1.8 (1.6); total body annules = 58–62 (61); spear = 56–58 um (57 um).

Holotype female: L = 0.35 mm; a = 8.4; b = 4.0; c = 14.7; V = 86; Va/VB = 1.7; total body annules = 62; spear = 59 um.

Description:

Body slightly ventrally curved upon fixation, fusiform tapering a little towards anterior end but more towards posterior extremity. Body annules 6 um apart at midbody, 14–17 annules in oesophageal region, 33–35 annules from oesophago-intestinal junction to vulva 4 or 5 annules from vulva to anus and 6 or 7 annules from anus to tail tip. Body annules thick, retrorse, bearing 8 longitudinal rows of scales; scales smooth, wider than long (fig. 16, D) at midbody. Lip region 7–8 um high, set off, marked with two annules, first annule hat-like, bearing small submedian lobes, 16 um wide, second annule rounded, collar-like, 13 um wide. First body annule retrorse, 21 um wide. Labial plates extending up to second lip annule. Metenchium 47–51 um or 85–86% of spear length. Basal knobs of spear 6–7 um across, located on 10–12th annule from anterior extremity. Orifice of dorsal oesophageal gland 3–6 um from spear base. Prometacorpus 14–15 um wide and basal bulb 5–6 um wide at their widest, basal bulb not much differentiated, but appears only an extended part of isthmus.

Nerve ring 79 um (n = 1) and oesophago-intestinal junction 83-92 um from anterior extremity. Excretory pore and hemizonid not observed. Spermatheca present, filled with sperms. Vulva with anterior overhanging vulval lip, located on 10 or 11th annule and anus on 6 or 7th annule from posterior extremity. Vulva-anus 4 or 5 annules apart, the distance less than one vulval body-width. Tail gradually tapering to a conoid terminus with 2 or 3 last annules free from scales, nearly two anal body-widths or about two times of vulva-anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of ferns and mosses from Mussoorie, Tehradun, Uttar Pradesh.

Type specimens: Collected in March 1978. Holotype on slide 4HS/15 Lcma paraoctannulare n. sp./1; paratype females on slides 4HS/15 Lcma paraoctannulare n. sp./2-6.

Differential diagnosis: Lcma paraoctannulare n. sp. comes close to Lcma octannulare (Cobb, 1914) Sch. Stekhoven & Teunissen, 1938, and L. coffeae (Edward et al., 1970) Andrássy, 1979. From L. octannulare it differs in having lesser annules on body, first lip annule wider than the second lip annule, and a smaller spear (first lip annule not wider than the second lip annule, but almost equal; R = 64-83; spear = 60-70 um in L. octannulare). From L. coffeae it

differs in having lesser number of body annules, in the absence of crenations on the scalers, differently shaped oesophageal bulb and lesser annules behind vulva (R = 75-85; scales with crenate or wevey margins; basal bulb of oesophagus well differentiated from isthmus; AV = 11-14 in *X. coffeae*).

[illegible] N. sp.
(Fig. 17)

Dimensions:

Paratype females (4): L = 0.26-0.29 mm (0.27 mm); a = 9.0-11.0 (10.0); b = 3.5-4.2 (3.8); c = 12.0-12.5 (12.0); V = 86-88 (87); VL/VB = 1.5; total body annules = 78-83 (79); spear = 39-46 um (44 um).

Holotype female: L = 0.27 mm; a = 9.0; b = 3.7; c = 20; V = 88; VL/VB = 1.5; total body annules = 83; spear = 45 um.

Description:

Body slightly curved upon fixation, cylindrical, tapering towards extremities. Body annules 3-4 um apart at midbody, 19-24 annules in oesophageal region, 43-47 annules from oesophago-intestinal junction to vulva, 4 annules from vulva to anus and 6 annules from anus to tail tip. Annules retrorse, marked with 10 longitudinal rows of scales. Scales more wider than longer (fig. 17, D) with smooth posterior

margins. Lip region 4-5 um high, set off, marked with two unequal annules, first annule with anteriorly directed margins, 9-11 um wide, second lip annule 11-13 um wide. The first body annule 15-16 um wide, retrorse. Metenchium 33-39 um or 84-85% of spear length. Basal knobs of spear 7-8 um across, located at 14-16th annule from anterior extremity. Prometacorpus 10-14 um wide and basal bulb 8-9 um wide at their widest. Nerve ring 58-64 um, oesophago-intestinal junction 66-75 um from anterior extremity. Excretory pore and hemizonid obscure. Spermathoca present, filled with sperms. Vulva located on 12 or 13th annule and anus on 8th annule from posterior extremity. Vulva-anus 4 annules apart, the distance about half of vulval body-width. Tail conoid, nearly one and half anal-body width long or one and half to two times of vulva-anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of apple, Malus pumila from Chemoli, Uttar Pradesh.

Type specimens: Collected in September 1978. Holotype on slide CH/11 Loma parvum n. sp./1; paratype females on slides CH/11 Loma parvum n. sp./2 & 3.

Differential diagnosis: Loma parvum n. sp. comes close to L. rhombocaudatum (Mehta & Raski, 1971) Andrássy, 1979 and

G. parectenculare n. sp. From G. rhombacaudatum it differs in having a smaller body, smaller spear and in the shape of tail (L = 0.33-0.40 mm; spear = 93-116 um and tail blunt in G. rhombacaudatum). From G. parectenculare n. sp. it differs in having smaller body, but larger number of body annules, smaller spear and anteriorly located vulva (L = 0.34-0.36 mm; R = 58-62; spear = 56-59 um; V = 84-86 in G. parectenculare n. sp.).

GCMA UERJ n. sp.
(Fig. 18)

Dimensions:

Paratype females (2): L = 0.39-0.45 mm; a = 10-11; b = 3.8-4.2; c = 7 ; V = 85-87; VL/VB = 1.6-1.8; total body annules = 66-69; spear = 75-78 um.

Holotype female: L = 0.39 mm; a = 11; b = 4.2; c =12 ; V = 87; VL/VB = 1.6; total body annules = 69; spear = 78 um.

Description:

Body slightly ventrally curved upon fixation, tapering towards extremities. Body annules 4-6 um apart at midbody, 17 or 18 annules in oesophageal region, 36-39 annules from oesophago-intestinal junction to vulva, and 13 annules from vulva to tail tip. Body annules thick, retrorse marked with 6 longitudinal rows of scales. Scales longer than wide, with

smooth margins. Lip region 9-10 um high, set off, marked with two unequal annules, first annule 14-15 um with its margins outwardly, laterally directed, second lip annule collar-like, 13-14 um wide. First body annule retrorse, 20-21 um wide. Metenchium 64-67 um or 85-87% of spear length. Basal knobs of spear 4-5 um across, located on 13 or 14th annule from anterior extremity. Orifice of dorsal oesophageal gland 3 um from spear base. Prometacorpus 17-18 um wide and basal bulb 8-9 um wide at their widest. Nerve ring 89-93 um, oesophago-intestinal junction 105-108 um from anterior extremity. Excretory pore located on 19th-21st annule from anterior extremity. Hemizonid obscure. Spermatheca present. Vulva located on 13th annule from posterior extremity. Anus on 7th (n = 1) annule from posterior extremity. Tail conoid, gradually tapering to a sub-acute terminus, one and half anal body-widths or about equal to vulva-anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of wild plants from Mulna village, Govindghat, Chamoli, Utter Pradesh.

Type specimens: Collected in September 1979. Holotype on slide CH/42 Lcma upam n. sp./1; paratype females on slides CH/42 Lcma upam n. sp./2 & 3.

Differential diagnosis: Lcma upam n. sp. comes close to Lcma octangulare (Cobb, 1914) Sch. Stekhoven & Teunissen, 1938

and *G. parectanculare* n. sp. From *G. octanculare* it differs in having the first lip annule bigger than second lip annule, longer spear, longer metenchium and more annules in region of spear (first lip annule not bigger than second lip annule; spear = 60-70 um; metenchium = 80-81% of spear length and Rat = 10-12 in *G. octanculare*). From *G. parectanculare* n.sp. it differs in having longer body, more annules on body and a longer spear (c = 0.34-0.36 mm; R = 58-62; spear = 56-60 um in *G. parectanculare* n. sp.).

KEY TO INDIAN SPECIES OF *GORA*

1. Annules behind vulva = 19; body with strongly pointed scales ..... *spinosum*
   Annules behind vulva = 7-15; body with blunt to rhomboid scales 2

2. Spear 39-46 um long ..... *parvum* n. sp.
   Spear 55-70 um long 3

3. Body annules bearing rows of blunt spines 7
   Body annules bearing rows of rhomboid scales 4

4. Cuticular appendages arranged in 8 longitudinal rows at mid-body 5
   Cuticular appendages arranged in 10 longitudinal rows at mid-body 8

5. Spear 56–59 um long; R = 58–62 ....
..... peroctangulare n. sp.

Spear 60–70 um long; R = 64–83 6

6. Spear 75–78 um long; first lip annule bigger than second lip annule; Rat = 13–14 .....wiwa n. sp.
Spear 60–70 um long; first lip annule not bigger than second lip annule; Rat = 10–12 ..... octangulare

7. First lip annule wider than second lip annule; RV =12–13; spear 55–60 um long ..... fotodari
First lip annule equal to second lip annule; RV=15; spear 68 um long .... simlaonais

8. Total body annules = 59–65; RV = 7–9 ..... rhosimum
Total body annules = 75–85; RV = 11–14 ..... ochona

GENUS SERIESPINULA MEHTA & RASKI, 1971 (KHAN, CHAWLA & SAHA, 1976)

Mehta & Raski (1971) erected Seriespinula as a subgenus of Criconema for those species of Criconema (sensu lato) which possess longitudinal rows of scale-like spines over their body annules. Khan et al. (1976) raised Seriespinula to generic level and added a new species to it. Andrássy (1979) while reviewing Criconematidae described two new species of Seriospinula and transferred some other species to this genus from other genera. The genus at present has 12 species and of these S. inmor, S. punici and S. tenuicaudata are known from India.

The diagnosis of the genus, a list of its species and record of two species, S. inmor and S. tenuicaudata from India is as follows:

Diagnosis: Criconematinae. Body small to moderate (0.30-0.64 mm) stout. Cuticle with 44-90 annules drawn out posteriorly in to spine-like projections in groups of 2-7, arranged in 8-20 (exceptionally 27 longitudinally arranged rows). Lip region marked with two annules, smooth or rarely crenate or fringed. Submedian lobes absent. Vulva with conical, closed lips. Posterior end of body generally conoid, rarely blunt.

Type species:

Seriospinula cobbi (Micoletzky, 1925) Khan, Chawla & Saha, 1976

Other species:

S. cactus Andrássy, 1979

S. coronata (Sch.Stekhoven & Teunissen,1938) Andrássy,1979

S. hunanica (Andrássy, 1962) Khan, Chawla & Saha, 1976

S. impar Khan, Chawla & Saha, 1976

S. malaysica Andrássy, 1979

S. octamonalis (Tomota & Ohshima,1974) Khan, Chawla & Saha,1976

S. panici (Edward, Misra & Rai,1971) Khan, Chawla & Saha,1976

S. sasacuri (Wu, 1965) Khan, Chawla & Saha, 1976

S. soklensis (Choi & Geraert,1975) Khan, Chawla & Saha,1976

S. tenuicaudata (Siddiqi, 1961) Khan, Chawla & Saha, 1976

S. venusta (Mehta & Raski,1971) Khan, Chawla & Saha, 1976

SCUTELLONEMA IMPAR KHAN, CHAWLA & SAHA, 1976
(Fig. 19)

Dimensions:

Females (6): L = 0.34–0.45 mm (0.39 mm); a = 6–8 (7); b = 2.5–3.3 (2.8); c = 8 (n = 1); V = 76–86 (83); VL/VB = 1.4–1.9 (1.6); total body annules = 51–59 (55); RV = 9–10 (9); Ran = 5 (n = 1); RVan = 4 (n = 1); Rst = 18–20 (19); Roeso = 22–23 (22); Rex = ? ; spear = 105–112 um (107 um); metenchium = 82–83 um.

Habitat and locality: Soil around roots of wild trees from Gopeshwar, Chamoli, Uttar Pradesh.

Remarks: These specimens are almost similar to those originally described except that they have a slightly shorter spear (112–120 um after Khan et al., 1976).

SERISPINULA TENUICAUDATA (SIDDIQI, 1961) KHAN, CHAWLA & SAHA, 1976

(Fig. 20)

Dimensions:

Females (11): L = 0.35–0.46 mm (0.41 mm); a = 7–8 (7); b = 2.6–3.2 (3.0); c = 8–14 (11); V = 84–91 (87); VL/VB = 1.1–2.0 (1.5); total body annules = 59–63 (60); RV = 10–11 (10); Ren = 5–7 (6); RVan = 3–4 (3); Rst = 16–19 (18); R oeso = 19–21 (20); Rex = 20 (n = 1); spear = 99–112 um (106 um); metanchium = 81–94 um.

Habitat and locality: Soil around roots of apricot, Prunus armeniaca from Koirala village, Ranikhet, Uttar Pradesh.

Remarks: Serispinula tenuicaudata was described by Siddiqi (1961) from Bhowali, Nainital from an altitude of about 1,692 m. The present specimens come from Ranikhet, Almora which is at an altitude of over 1000 m and are similar to those described by Siddiqi (1961).

KEY TO INDIAN SPECIES OF SERISPINULA

1. Body annules provided with 12–14 longitudinal rows of scales at midbody, each scale made up of spines of varying sizes; spear 99–120 um long 2

   Body annules provided with 6 longitudinal rows of scales at midbody, each scale with irregular margins; spear 65–70 um long... .... Panici

2. Body with 12 rows of scales at midbody ..... imper

   Body with 14 rows of scales at midbody.....tenuicaudata

GENUS MACROPOSTHONIA DE MAN, 1880

The genus Macroposthonia was described only on the males by De Man (1880) to accommodate M. annulata. Later, another male specimen of M. annulata was described by him in 1921, but Filipjev (1936) thought it to be the male of the genus Paratylenchus. Kischke (1956) described some males from Germany which according to Siddiqi & Goodey (1964) were very much similar to those described by De Man (1880) in the shape of spicules, anal sheath and the pattern of termination of lateral fields on the rudimentary bursa. De Grisse & Loof(1965) and Loof & De Grisse (1967) were of the opinion that the corresponding females of M. annulata De Man (1880) and Kischke (1956) were described by Andrássy (1962) as Criconemoides kirjanovae. Consequently, they designated the latter species as Macroposthonia annulata and thereby revalidated the genus Macroposthonia De Man, 1880. Tarjan (1966) and Raski & Golden (1966) did not agree with the revalidation of Macroposthonia by De Grisse & Loof. Heyns (1970) accepted the proposals of De Grisse & Loof (1965) and De Grisse (1967). Loof & De Grisse (1973) again considered genus Macroposthonia as valid. Khan et al. (1976) also accepted Macroposthonia as valid and proposed a closely related new genus, Madinema and a new family Madinematidae. Andrássy (1979) rejected Madinematidae of Khan et al. (1976) as its proposal was against

the rules of the Zoological nomenclature. He, however, retained the subfamily Macropsthoniinae and the genus Macronsthonia as valid. A large number of species under this genus have been described and perhaps much more species await description. At present, 65 species are recognized under this genus. Eleven of these are already recorded from this country, viz., Macronsthonia basili, M. complexa, M. insignis, M.nainitalensis, M. neoaustus, M. oschiarai, M. oncensa, M. onostris, M. pruni, M. rusium, M. sphaerocephala. Another two known species, M. obtusicaudatum and M. rustica are being recorded in the present work for the first time from India. In addition, three new species of Macronsthonia are also being described and illustrated. A list of the nominal species and diagnosis of the genus is given below.

Diagnosis: Macropsthoniinae. Female cylindrical, tapering on either extremities. No cuticular sheath. Annules in females with rounded outline, posterior margins either smooth or with slight, fine ornamentations or rough but never with distinct scales, spines or fringe. Lip region never low and rounded, mostly with submedian lobes and often also with labial plates. Vulva mostly a wide aperture. Males with bursa and four lateral lines. Juveniles without rows of scales on posterior edges of annules, but fine continuous ornamentation often present.

Type species:

Macromonhonia annulata De Man, 1880

Other species:

M. amoribus De Grisse, 1965

M. antarcolitana (De Guiran, 1963) De Grisse & Loof, 1965

M. axenta (Paesuliotis & Williamson, 1959)
De Grisse & Loof, 1965

M. axenia van den Berg, 1979

M. bakeri (Wu, 1965) De Grisse & Loof, 1965

M. basili (Jairajpuri, 1964) De Grisse & Loof, 1965

M. brintaiensis Heyns, 1970

M. boljaevae (Kirjanova, 1948) Ivanova, 1976

M. caballeroi Gradovera, 1976

M. complexa (Jairajpuri, 1963) De Grisse & Loof, 1965

M. crassicauda De Grisse, 1967

M. crenata (Loof, 1964b) De Grisse & Loof, 1965

M. curvata (Raski, 1952) De Grisse & Loof, 1965

M. facinae (Luc, 1959) De Grisse & Loof, 1965

M. hemithoracicaudata (Wu, 1965) De Grisse & Loof, 1965

M. hispalensis (Arias Lopez & Jimenez, 1963)
De Grisse & Loof, 1965

M. hisca van den Berg, 1979

M. informis (Micoletzky, 1922) De Grisse & Loof, 1965

M. insignis (Siddiqi, 1961) De Grisse & Loof, 1965

M. irregularis (De Grisse, 1964b) De Grisse & Loof,1965

M. krallii Ivanova, 1976

M. longistylata De Grisse & Maas, 1970

M. macrolobata (Jairajpuri & A. H. Siddiqi, 1963)
De Grisse & Loof, 1965

M. malusi Razzhivin, 1974

M. maritima (De Grisse, 1964b) De Grisse & Loof, 1965

M. meekata Heyns, 1970

M. microdora (De Grisse, 1964b) De Grisse & Loof, 1965

M. nainitalensis (Edward & Misra, 1963)
De Grisse & Loof, 1965

M. neoamoenus (Jairajpuri & A. H. Siddiqi, 1963)
De Grisse & Loof, 1965

M. oschioraï Khan, Seshadri, Maicher & Mathen, 1971

M. obtusicaudatus (Heyns, 1962) Heyns, 1970

M. oneosus (Luc, 1959) De Grisse & Loof, 1965

M. onostris Khan & Ganval, 1980

M. ornata (Raski, 1958) De Grisse & Loof, 1965

M. paludestris (Luc, 1970) Loof & De Grisse, 1973

M. parvoovi Razzhivin, 1974

M. parvulus (Steiner, 1920) De Grisse & Loof, 1965

M. pruni (Siddiqi, 1961) De Grisse & Loof, 1965

M. pseudobeyrouthensis (De Grisse & Roen, 1964)
De Grisse & Loof, 1965

M. Pseudoconilvaca (De Grisse, 1964b)
De Grisse & Loof, 1965

M. pulla (Kirjanova, 1948) De Grisse & Loof, 1965

M. quandricornis (Kirjanova, 1948) De Grisse & Loof, 1965

M. ruskiensis (De Grisse, 1964b) De Grisse & Loof, 1965

M. rosae (Loof, 1964b) De Grisse & Loof, 1965

M. rotundicauda (Loof, 1964b) De Grisse & Loof, 1965

M. rotundicaudata (Wu, 1965) De Grisse & Loof, 1965

M. rusium Khan, Chawla & Saha, 1976

M. rustica (Nicoletsky, 1915) De Grisse & Loof, 1965

M. similis (Cobb, 1918) De Grisse & Loof, 1965

M. sicilicronata Prodovera, 1976

M. soliveca (Andrássy, 1962) De Grisse & Loof, 1965

M. sosamosai Prodovera, 1976

M. sphaerocephala (Taylor, 1936) De Grisse & Loof, 1965

M. surinamensis (De Grisse, 1970) Loof & De Grisse, 1973

M. taylori (De Man, 1880) De Grisse & Loof, 1965

M. texas (Raski, 1952) De Grisse & Loof, 1965

M. tenuicutis (Kirjanova, 1948) De Grisse & Loof, 1965

M. tenuorum (De Guiran, 1963) De Grisse & Loof, 1965

M. tulgomovi (Kirjanova, 1948) De Grisse & Loof, 1965

M. vadensis (Loof, 1964b) De Grisse & Loof, 1965

M. volgaica Choi & Geraert, 1975

M. xenoplax (Raski, 1952) De Grisse & Loof, 1965

M. yamanensis (Luc, 1970) Loof & De Grisse, 1973

M. yossifovichi (Kmjaic, 1967) Loof & De Grisse, 1973

M. paraxesta n. sp.

M. kalincai n. sp.

M. mandalensis n. sp.

The genus Macroposthonia is one of the most commonly distributed genera. Its species occur around roots of grasses, different types of crops, fruit trees, ornamental plants, forest trees, etc. These are found in the hills as well as on the plains. In the present work, 24 populations of this genus were recorded which represent 12 species. Three of these are new to science and have been described in detail, the other nine are known species.

MACROPOSTHONIA BASILI (JAIRAJPURI, 1963) DE GRISSE & LOOF, 1965
(Fig. 21)

Dimensions:

Females (3): L = 0.49-0.50 mm; a = 12-14; b = 4.0-4.9; c = 105; V = 95-96; VL/VB = 0.6-0.8; total body annules = 70-74; RV = 4-5; Ran = 1; RVan = 3-4; Rst = 11-12; Rocso = 15-19; Rex = 17-21; spear = 68 um; metenchium = 53 um.

Habitat and locality: Soil around roots of wild trees from Rishikesh, Saharanpur, Uttar Pradesh.

Remarks: Macroposthonia basili was originally described by

Jairajpuri in 1963 as Criconemoides goodeyi. He renamed it as C. basili because C. goodeyi was preoccupied. De Grisse & Loof (1965) transferred this species to the genus Macrosthonia. The present specimens show similarities with those described by Jairajpuri (1963) except for a slightly smaller body and spear (L = 0.54-0.60 mm and spear 68-74 um by Jairajpuri, 1963).

MACROSTHONIA COMPLEXA (JAIRAJPURI,1963) DE GRISSE & LOOF,1965
(Fig. 22, A-E)

Dimensions:

i) Nilkhanta, Chamoli, Uttar Pradesh population:

Females (8): L = 0.49-0.51 mm (0.42 mm); a = 11-12 (11); b = 4.2-4.3 (3.8); c = 30-31; V = 92-93 (92); VL/VB = 1.2-1.3; total body annules = 59-62 (60); RV = 6; Ran = 3; RVan = 3; Rst = 10-11; Roeso = 16; Rex = 20; spear = 68-71 um (69 um); metenchium = 53-54 um.

ii) Apricot, Kathmandu, Nepal population:

Females (5): L = 0.40-0.44 mm (0.43 mm); a = 11-13 (11); b = 2.9-4.3 (4.0); c = ? ; V = 93; VL/VB = 1.0-1.4 (1.3); total body annules = 63-72 (70); RV = 5-7(6); Ran = 3-4 (4); RVan = 3; Rst = 12-13 (12); Roeso = 17-18 (17); Rex = ? ; spear = 60-63 um (60 um); metenchium = 45-47 um.

iii) Wild plants, Malekhu, Nepal population:

Females (8): L = 0.40-0.46 mm (0.44 mm); a = 10-13 (11); b = 2.6-3.9 (3.5); c = 18.2 - 19.8 (19.0); V = 92-94 (93); VL/VB = 0.8-1.5 (1.1); total body annules = 69-74 (72); RV = 6-7 (6); Ran = 5; RVan = 1; Rst = 11-14 (13); Roeso = 17-21 (19); Rex = 22 (n = 1); spear = 60-63 um (61 um); metenchium = 48-51 um.

iv) Wild plant, Cotacamund, Tamil Nadu population:

Females (3): L = 0.41-0.50 mm (0.48 mm); a = 11-13 (12); b = 4.1-4.7 (4.4); c = ? ; V = 92-93; VL/VB = 0.8-1.3 (1.1); total body annules = 66-69 (67); RV = 6-7 (6); Ran = ? ; RVan = ? ; Rst = 11-12 (12); Roeso = 16-19 (18); Rex = 18 (n = 1); spear = 62-63 um (63 um); metenchium = 44-45 um.

Habitats and localities: Soil around roots of i) wildplants from Chengharia, Chamoli, Uttar Pradesh; ii) apricot, Prunus armeniaca from horticultural farm, Godawari, Kathmandu, Nepal; iii) wildplants from Malekhu, Nepal; iv) wildplants from Cotacamund, Tamil Nadu.

Remarks: Macroposthonia complexa was first described under Criconemoides (sensu lato) by Jairajpuri (1963). De Grisse & Loof (1965) transferred it to the genus Macroposthonia. The species appears to be fairly widely distributed.

MACROSTOMELLA CETUSICAUDATUM (HEYNS, 1962) HEYNS, 1970
(Fig. 23, D-F)

Dimensions:

i) Paddy, Khangabok, Manipur population:

Females (7): L = 0.35-0.47 mm (0.41 mm); a = 11-12 (12); b = 3.7-4.7 (4.2); c = 18-23 (21); V = 89-94 (91); VL/VB = 0.8-1.1 (1.0); total body annules = 83-91 (87); RV = 7-9 (8); Ran = 5-8; RVan = 1; Rat = 11-15 (13); Rosso = 20-24 (23); Rex = 26; spear = 47-51 um (49 um); metenchium = 36-38 um.

ii) Grasses, Kohima, Nagaland population:

Females (4): L = 0.40-0.47 mm (0.44 mm); a = 11-12 (12); b = 4.1-4.5 (4.3); c = 21-24 (23); V = 93-94 (93); VL/VB = 0.8-0.9 (0.8); total body annules = 86-97(92); RV = 7-8 (8); Ran = 4-5 (4); RVan = 2-3 (2); Rat = 13-14 (13); Rosso = 23-24 (23); Rex = 24-25 (24); spear = 50-53 um (52 um); metenchium = 38-41 um.

iii) Sugarcane, Gauhati, Assam population:

Females (4): L = 0.37-0.45 mm (0.41 mm); a = 10-13 (12); b = 3.8-4.5 (4.0); c = 23-31 (27); V = 93-94 (93); VL/VB = 0.8-1.1 (1.0); total body annules = 85-94(88); RV = 5-8 (7); Ran = 4-5 (4); RVan = 1-3 (2); Rat = 13-15 (14); Rosso = 24-25 (24); Rex = 24; spear = 48-53 um(52 um); metenchium = 36-39 um.

iv) Wild trees, Chamoli, Utter Pradesh population:

Females (7): L = 0.37-0.45 mm (0.41 mm); a = 12-14 (13); b = 3.6-4.2 (3.8); c = 17-21 (19); V = 92-94 (93); VL/VB = 1.4-1.5 (1.4); total body annules = 93-98 (95); RV = 6-8 (8); Ren = 4-5 (5); RVen = 2-3 (2); Rst = 13-15 (13); Roeso = 23-24 (24); Rex = 23; spear = 47-54 um (51 um); metenchium = 37-40 um.

Habitats and localities: Soil around roots of i) paddy, Oryza sativa from Khangabok, Thoubal, Manipur; ii) grasses from Kohima hills, Manipur road, Nagaland; iii) pineapple, Ananus comosus from Gauhati University, Assam; iv) wild trees from Ghangharia, Chamoli, Utter Pradesh.

Remarks: The species has been recorded for the first time from India. The present specimens agree well with those described by Heyns (1962) except that they have more annules on body (72-84 annules after Heyns, 1962).

MACROPOSTHONIA ONOENSE (LUC, 1959) DE GRISSE & LOOF, 1965
(Fig. 23, A-C)

Dimensions:

Females (14): L = 0.41-0.54 mm (0.47 mm); a = 11-13 (12); b = 3.4-5.1 (3.8); c = 14-22 (18); V = 91-94 (92); VL/VB = 0.9-1.4 (1.1); total body annules = 116-136

(127); RV = 9-11 (10); Ran = 6-10 (8); RVan = 2-4 (3); Rst = 18-23 (19); Roeso = 29-35 (33); Rex = 31-36 (33); spear = 49-60 um (57 um); metenchium = 39-58 um.

Habitats and localities: Soil around roots of i) pinus, Pinus longifolia from Mussoorie, Dehradun, Uttar Pradesh; ii) roses, Rosa alba from Botany Block, Kirtipur, Kathmandu, Nepal; iii) paddy, Oryza sativa from Yannam Kunao, Imphal, Manipur.

Remarks: Macroposthonia onoensa was described by Luc (1959). Baqri (1979) has reported it from West Bengal, India. The present specimens conform well with those described by Luc (1959), Raski & Golden (1965) and Baqri (1979). The species is of common occurrence in the hills, but is also found in plains though rarely.

MACROPOSTHONIA ONOENSIS MUKAN & BANERJI, 1980
(Fig. 24)

Dimensions:

Females (5): L = 0.47-0.56 mm (0.53 mm); a = 11-14 (13); b = 4.1-5.1 (4.4); c = 15-19 (17); V = 72-92 (84); VL/VB = 1.2-1.3 (1.2); total body annules = 124-138 (131); RV = 10-11; Ran = 8; RVan = 2-3; Rst =

18–20 (19); Roesc = 31–35 (33); Rex = 28–34 (33); spear = 56–60 um (57 um); metenchium = 35–46 um.

Habitat and locality: Soil around roots of peach, Prunus persica from Fruit Development Centre, Kirtipur, Kathmandu, Nepal.

Remarks: Phuken & Sanwal (1980) recently described Macromonhystera cucatria from Assam which they found associated with brinjal roots. The present specimens exhibit some differences from those described by Phuken & Sanwal in the posterior location of vulva, lesser annules in the oesophageal region and behind vulva (V = 92–96; Roesc = 35–38; Rst = 20–22; RV = 7–9 after Phuken & Sanwal, 1980).

MACROMONHYSTERA TERLI (SIDDIQI, 1961) DE GRISSE & LOOF, 1965 (Fig. 25)

Dimensions:

Females (14): L = 0.51–0.61 mm (0.59 mm); a = 12–17 (14); b = 3.7–5.0 (4.4); c = 23–33 (28); V = 93–95 (94); VL/VB = 0.7–1.0 (0.9); total body annules = 92–112 (98); RV = 7–8 (7); Rm = 5–6 (5); RVan = 2; Rst = 13–16 (14); Roesc = 20–26 (23); Rex = 27; spear = 64–70 um (66 um); metenchium = 54–56 um.

Males (2): L = 0.32–0.34 mm; a = 9.8; b = ?; c = 11–12; T = 30–39; spicule = 20 um; gubernaculum = 4um;

bursa = 6 um.

Habitats and localities: Soil around roots of i) pear, Pyrus communis from Godewari orchards, and apple, Malus sylvila from National Park, Kathmandu, Nepal; ii) plum, Prunus communis, apple, Malus sylvila and peach, Prunus persica from Mussoorie, Dehradun, Uttar Pradesh.

Remarks: Siddiqi (1961) described it from soil around roots of apricot, Prunus armeniaca; pear, Pyrus communis and apple, Malus sylvila from an altitude of 1500-2300 m. It is a widely distributed species mainly associated with the fruit trees. The present specimens which are from different localities are similar to those of Siddiqi (1961).

MACROTROPHURUS RUSIUM KHAN, CHAWLA & SAHA, 1976
(Fig. 26)

Dimensions:

Females (3): L = 0.40-0.42 mm; a = 10-11; b = 3.6-3.9; c = 37-45; V = 93-95; VL/VB = 0.7; total body annules = 77-89; RV = 5; Ran = 2; RVan = 3; Rat = 16-19; Roeso = 24; Rex = 24-26; spear = 52-53 um; metarchium = 40 um.

Habitat and locality: Soil around roots of Citrus sp. from Rangarh, Haldwani, Uttar Pradesh.

Remarks: These specimens conform well with those described by Khan et al., 1976.

MACROTROPHIA AUSTICA (MICOLETZKY, 1915) DE GRISSE & LOOF, 1965
(Fig. 22, F-J)

Dimensions:

Females (7): L = 0.33-0.40 mm (0.37 mm); a = 9.0-11.0 (10.0); b = 3.0-4.0 (3.7); c = 22-27 (25); V = 93-94 (93); VL/VB = 0.7-0.9 (0.8); total body annules = 100-116 (106); RV = 7; Ran = 5; RVan = 2; Rst = 18; Roeso = 30; Rex = 30; spear = 47-53 um (50 um); metenchium = 37-42 um.

Habitats and localities: Soil around roots of i) apple, Pyrus malus from Nuncipal Gardens, Mussoorie, Dehradun, Uttar Pradesh; ii) apricot, Prunus armeniaca from Union Bank, Mussoorie, Dehradun, Uttar Pradesh.

Remarks: The species has been recorded for the first time from this country and the Indian specimens fit well with those described earlier.

MACROSTHONIA SEMIARCUATA (TAYLOR, 1936) DE GRISSE & LOOF, 1965
(Fig. 23, G-I)

Dimensions:

Females (15): L=0.31-0.37 (0.35 mm); a = 8-10 (9); b = 2.9-3.4 (3.0); c = 28-45 (42); V = 94-97 (95); VL/VB =

0.7-0.8 (0.7); total body annules = 61-65 (64); RV = 4-6(5); Ran = 2; RVan = 2-3; Rst = 11; Aoeso = 18-23 (21); Rex = 23; spear = 49-51 um (50 um); metenchium = 34-38 um.

Habitats and localities: Soil around roots of i) paddy, Oryza sativa from Yumnam Kunao, Imphal, Manipur; ii) pea, Pisum sativum from Mawana, Meerut, Uttar Pradesh.

Remarks: Macromorphonia sphaerocephala is cosmopolitan associated with the roots of different crops. The specimens of this species collected in the present study are similar to those described by Raski & Golden (1965) except that they possess lesser annules on body and a slightly smaller spear (total body annules 65-79; spear 47-57 um according to Raski & Golden, 1965).

PARATYLENCHUS PARAXESTE N. SP.
(Fig. 27)

Dimensions:

Paratype females (5): L = 0.34-0.42 mm (0.38 mm); a = 8-10 (9); b = 3.4-3.8 (3.6); c = 33-42 (38); V = 92-94 (93); VL/VB = 0.6-1.0 (0.9); total body annules = 58-66 (62); spear = 60-66 um (64 um);

Holotype female: L = 0.35 mm; a = 9; b = 3.4; c = 33; V = 93; VL/VB = 0.8; total body annules = 60; spear = 63 um.

Description:

Body slightly ventrally curved upon fixation, tapering towards extremities. Body annules 4-5 um apart at midbody, 17-19 annules in oesophageal region, 36-43 annules from oesophago-intestinal junction to vulva, 2 annules from vulva to anus and 3 or 4 annules from anus to tail tip. Annules finely crenate, without any anastomosing . Lip region continuous, marked with two annules, first lip annule 15-17 um wide, second lip annule 18-21 um wide. First body annule 20-25 um wide. First lip annule bearing a prominent labial disc and four distinct, slightly projecting submedian lobes. Labial framework weakly developed, extending through first lip annule. Metanchium 51-54 um long or 82-87% of spear length. Basal knobs of spear 8-9 um across, located on 9-11th annule from anterior extremity. Orifice of dorsal oesophageal gland 2 um from spear base. Prometacorpus 18-19 um wide and basal bulb 9-11 um wide at their widest. Nerve ring 85-95 um and oesophago-intestinal junction 99-106 um from anterior extremity. Excretory pore located on 17-20th annule from anterior extremity. Hemizonid obscure. Vulva located on 4 or 5th annule and anus on 2nd or 3rd annule from posterior extremity. Vulva-anus 2-3 annules apart, the distance less than half of vulval body-width long. Tail short, bluntly rounded, less than one anal body-width long or nearly equal to vulva-anus distance.

Male: Not found.

Type habitat and locality: Soil around roots of papaya, Carica papaya from Singjamei Thongam Leikai, Imphal, Manipur.

Type specimens: Collected by Dr. Dhanachand Chongtham in August 1978. Holotype on slide Macroposthonia parexcate n.sp./1; paratype females on slides Macroposthonia parexcate n.sp./2-4.

Differential diagnosis: Macroposthonia parexcate n. sp. comes close to M. oschiarai Khan et al., 1976 and M. excate (Basuliotis & Williamson, 1959) De Grisse & Loof, 1965. From M. oschiarai it differs in having differently shaped and larger annules on body, differently shaped lip region, in having a longer spear, smaller oesophagus, in the location of excretory pore and more annules behind vulva and anus (R = 45-50 with rough margins; spear = 54-60 um; b = 3.0-3.4; Rex = 16; RV = 2-3 and Ran = 1-2 in M. oschiarai). From M. excate it differs in having larger number of annules on body which are smooth, in the different shape of lip region, in having a longer spear, oesophagus, in the location of excretory pore and in having a smaller tail (R = 42-54 rough annular edges; spear = 51-60 um; b = 3.0-4.2; Rex = 12-15; c = 24-31 in M. excate).

LACRODONTOLA [illegible] n. sp.

(Fig. 28)

Dimensions:

Paratype female: L = 0.36 mm; a = 11; b = 3; c = 59; V = 95; VL/VB = 0.7; total body annules = 81; spear = 65 um.

Paratype males (2): 0.40-0.41 mm; a = 19-21; b = 3-4; c = 14-19; T = 54-61; spicules = 27-28 um; gubernaculum = 9 um; bursa = 12 um.

Holotype female: L = 0.36 mm; a = 11; b = 3.3; c = 59; V = 95; VL/VB = 0.6; total body annules = 80; spear = 62 um.

Descriptions:

Female: Body cylindrical, ventrally curved upon fixation, tapering slightly towards extremities. Body annules 5 um apart at midbody, 24-26 annules in oesophageal region, 51 annules from oesophago-intestinal junction to vulva, 3 or 4 annules from vulva to anus and 1 or 2 annules from anus to tail tip. Annules retrorse, their posterior margins smooth, occasional anastomoses of annules present. Lip region continuous, 6 um high, conoid, marked with two annules, first annule 13-14 um wide, second lip annule 15 um wide. First annule bearing

prominent submedian lobes. Labial framework sclerotized. Labial plates well developed. Metenchium 50-55 um long or 81-85% of spear length. Basal knobs of spear 8-9 um across, located on 15 or 16th annule from anterior extremity. Orifice of dorsal oesophageal gland nearly 4 um from spear base. Promotacorpus 16-18 um wide and basal bulb 9-11 um wide at their widest. Nerve ring 90-98 um and oesophago-intestinal junction 107-115 um from anterior extremity. Cardia present. Excretory pore located on 24-26th annule from anterior extremity. Spermatheca present. Vulva simple, located on 4 or 5th annule and anus on 1st or 2nd annule from posterior extremity. Vulva-anus 2 or 3 annules apart, the distance about half of vulval body-width. Tail extremity short, less than half anal body-width or half of the vulva-anus distance long.

Male: Cuticular sheath absent. Lip region continuous, 6 um high, 10-12 um across. Lateral fields with two incisures, one-fourth body-width wide. Spear absent. Oesophagus degenerate. Excretory pore 105-108 um and hemizonid 98-105 um from anterior extremity. Spicules 27-28 um, slightly arcuate. Gubernaculum trough-shaped, 9 um and bursa 12-14 um long. Tail bluntly-conoid one-half anal body-width long.

Type habitat and locality: Soil around roots of water weeds from Cuttack, Orissa.

Type specimens: Collected in March 1979. Holotype on slide OR/3 Macroposthonia kelingai n. sp./1; paratype female on slide OR/3 Macroposthonia kelingai n. sp./2; paratype males on slides OR/3 Macroposthonia kelingai n. sp./3,4.

Differential diagnosis: Macroposthonia kelingai n. sp. comes close to M. basili (Jairajpuri, 1963) De Grisse & Loof, 1965 and M. antenolitana (De Guiran, 1963) De Grisse & Loof, 1965. From M. basili it differs in having a smaller body, more annules on body, in the region of spear, a longer spear, shorter telenchium, in having a longer oesophagus and in the presence of males (L = 0.49-0.60 mm; R = 70-74; Rat = 11-12; spear = 68-74 um; telenchium = 15-16 um; b = 4.2-4.9 and males absent in M. basili). From M. antenolitana it differs in having a smaller body, lesser annules on body and behind vulva, a shorter telenchium, in the presence of a spermatheca, a more posteriorly located vulva and anus, a shorter tail and in the presence of males (c = 0.37-0.50 mm; R = 85-90; RV = 7-8; spermatheca absent; V = 93-94; telenchium = 16-18 um; anus anterior; c = 29-37 and males absent in M. antenolitana).

MACRONEMA MANDALAENSIS N. SP.
(Fig. 29)

Dimensions:

Paratype females (4): L = 0.40-0.42 mm (0.41 mm); a = 9-10 (10); b = 3.6-4.0 (3.7); c = 28-29; V = 93-95; VL/VB = 0.7-0.9 (0.8); total body annules = 68-72 (70); spear = 66-68 um (66 um);

Holotype female: L = 0.41 mm; a = 10; b = 4.0; c = 29; V = 93; VL/VB = 0.9; total body annules = 71; spear = 66 um.

Description:

Body slightly ventrally curved upon fixation, only a little tapering towards extremities. Body annules 6 um apart at midbody, 17-19 annules in oesophageal region, 46-48 annules from oesophago-intestinal junction to vulva, 2 annules between vulva and anus, 2or 3 annules from anus to tail tip. Annules retrorse, with posterior margins crenate, a few anastomoses of annules present. Lip region 9 um high, distinct, marked with two annules, first lip annule 15-17 um wide bearing disc with submedian lobes, second lip annule 19-20 um wide. First body annule 22-23 um wide. Metanchium 51-52 um long or 77-78% of spear length. Basal knobs 10 um across, located on 12 or 13th annule from anterior extremity. Orifice of dorsal oesophageal

gland 5-6 um from spear base. Prostacorpus 19-20 um wide and basal bulb 11-12 um wide at their widest. Nerve ring 80-95 um and oesophago-intestinal junction located on 98-108 um from anterior extremity. Excretory pore and hemizonid not observed. Spermatheca present. Vulva located on 5th annule and anus on 3rd annule fro posterior extremity. Vulva-anus 2 annules apart, the distance less than one vulval body-width. Tail rounded, about half anal body-width or nearly less than one vulva-anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of grasses from Mandal, Chamoli, Uttar Pradesh.

Type specimens: Collected in September 1979. Holotype on slide CH/36 Macroposthonia mandalensis n. sp./1; paratype females on slides CH/36 Macroposthonia mandalensis n. sp./2-5.

Differential diagnosis: Macroposthonia mandalensis n. sp. comes close to M. oostenbrinki (Loof, 1964a) De Grisse & Loof, 1965 and M. paraexcata n. sp. From M. oostenbrinki it differs in having lesser annules on body and behind vulva, anus, a short post-vulval part and a round tail (R = 84-94; RV = 10; Ran = 6; post-vulval part elongate and tail conoid in M. oostenbrinki). From M. paraexcata n. sp. it differs in having more annules on

body, in the region of spear, in having longitudinal markings on the posterior margins of annules, a longer telenchium and shorter tail (R = 58-66; Rat = 9-11; longitudinal markings absent, only margins of annules rough; telenchium 7-12 um and c = 28-29 in *L. paraxesta* n. sp.).

KEY TO INDIAN SPECIES OF *HACKSPORIDIA*

1. Annules on body smooth 2
   Annules on body crenate 8

2. Body annules numbering 100-136 3
   Body annules numbering 60-96 4

3. RV = 7; body annules 100-110 ..... *neinitalensis*
   RV = 9-11; body annules 115-136 ..... *sinensis*

4. Body length = 0.31-0.36 mm 5
   Body length = 0.40-0.60 mm 6

5. Spear 49-51 um long; body annules = 61-65 .....
   ..... *sphaerocephala*
   Spear 62-65 um long; body annules = 80-81.....
   ..... *kalingai* n. sp.

6. Spear 77-96 um long ..... *rusium*
   Spear 60-74 um long 7

7. Tail short, bluntly rounded; vulva with a bilobed cuticular flap; Ran = 1 ..... basili

Tail elongate-conoid; vulva without a bilobed cuticular flap; Ran = 4 ..... complexa

8. Body annules numbering 42-54 9

Body annules numbering 58-138 10

9. RV = 5; first and second annules of lip region anteriorly directed ..... neoasetatus

RV = 2-3; first and second annules of lip region laterally directed ..... oschairai

10. RV = 10-11 ..... oroatria

RV = 4-9 11

11. Spear 47-54 um long 12

Spear 60-70 um long 13

12. Body annules = 83-98 ..... obtusicaudatum

Body annules = 100-116 ..... rustica

13. Submedian lobes absent; terminal warts on tail absent .....
..... insignis

Submedian lobes present; terminal warts on tail present ...
..... 14

14. Body annules heavily crenate; body length = 0.51-0.61 mm ..
..... pruni

Body annules finely crenate; body length = 0.34–0.42 mm..
..... 15

15. Anastomoses of annules absent; body annules = 58–66; spear 60–65 um long; metenchium 82–87% of spear length .....
..... *parexenta* n. sp.
Anastomoses of annules present; body annules =68–72; spear 66–68 um long; metenchium 77–78% of spear length .....
..... *mandelamaia* n. sp.

GENUS CRICONEMELLA DE GRISSE & LOOF, 1965

De Grisse & Loof (1965) while reviewing the genus Criconemoides, raised this genus to accommodate certain heavily annulated species of the erstwhile genus Criconemoides. Tarjan (1966), Raski & Golden (1966) and Luc (1970) did not agree with the proposal of this genus and synonymized it with Criconemoides. However, De Grisse (1969), Heyns (1970), Loof & De Grisse (1973), Khan et al. (1976) and Andrássy (1979) have recognized Criconemella as valid. So far, six species of this genus have been described from all over the world, but only one species, C. parvula was reported from this country. In the present work another species, which also incidentally is a new one is being described and illustrated. The diagnosis of the genus and a list of its species is as under.

Diagnosis: Macroposthoniinae. Small sized nematodes (0.18-0.32 mm) assuming a closed 'C'-shaped upon fixation. Body annules mostly angular in outline numbering 90-200, posterior margins of annules smooth or finely crenate. Lip region truncate. Submedian lobes present or absent. More than 30 annules anterior to excretory pore. Males with bursa.

Type species:

Criconemella parva (Raski, 1952) De Grisse & Loof, 1965

Other species:

C. onodevi (De Guiran, 1963) De Grisse & Loof, 1965

C. myungsanae Choi & Geraert, 1975

C. paraonodevi Choi & Geraert, 1975

C. parvula (Siddiqi, 1961) De Grisse & Loof, 1965

C. savadskii (Tulaganov, 1941) De Grisse & Loof, 1965

C. endrássyi n. sp.

CRICONEMOIDES ENDRÁSSYI n. sp.
(Fig. 30)

Dimensions:

Paratype female: L = 0.34 mm; a = 11; b = 4.5; c = 7 ; V = 94; VL/VB = 1.0; total body annules = 124; spear = 42 um.

Holotype female: L = 0.33 mm; a = 12; b = 4.3; c = 12; V = 94; VL/VB = 0.9; total body annules = 126; spear = 46 um.

Description:

Body assumes a closed C-shaped posture upon fixation, only slightly tapering towards extremities. Body annules 3 um wide at midbody, 30-31 annules in oesophageal region, 85-88 annules from oesophago-intestinal junction to vulva, two annules from vulva to anus and 7 or 8 annules from anus to tail tip. Body annules finely crenate, showing occasional anastomoses (fig. 30, D).

Lip region disc-like, 3-4 um high, marked with two annules, first lip annule 7-8 um, angular and second lip annule retrorse. Metenchium 35-38 um or 82-83% of spear length. Basal knobs of spear 8 um across, located on 24th annule from anterior extremity. Orifice of dorsal oesophageal gland 3-4 um from spear base. Prometacorpus 12-15 um wide and basal bulb 9-11 um wide at their widest. Nerve ring 73-74 um and oesophago-intestinal junction 80-82 um from anterior extremity. Excretory pore 89 um, located on 40th annule from anterior extremity. Hemizonid not observed. Spermatheca non-functional, gonad well developed reaching upto the prometocorpus. Vulva located on 9 or 10th annule and anus on 7 or 8th annule from posterior extremity. Vulva-anus 2 or 3 annules apart, the distance about one-third of vulval body-width. Tail short, tapering to an irregularly indented tip annule, nearly one anal body-width or more than one and half times of vulva anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of wild trees in the vicinity of Electricity Board Office, near Silent Valley, project site, Malapurum, Kerala.

Type specimens: Collected in September 1980. Holotype on slide ST/44 Criconemella andrássyi n. sp./1; paratype female on slide ST/44 Criconemella andrássyi n. sp./2.

Differential diagnosis: Criconemella andrássyi n. sp. comes close to C. goodeyi (De Guiran, 1963) De Grisse & Loof, 1965 and C. myuncauda Choi & Geraert, 1975. From C. goodeyi it differs in having a longer body, body annules finely crenate and a longer spear (L = 0.20-0.27 mm; annules heavily crenate and spear = 33-38 um in C. goodeyi). From C. myuncauda it differs in having a smaller body, lesser anastomoses of annules, a shorter spear and tail (L = 0.44-0.50 mm; annules heavily anastomosed; spear = 66-68 um and tail two anal body-widths long in C. myuncauda).

The new species is named in honour of Dr. I. Andrássy, D.Sc. of the Eötvös Loránd University, Budapest, Hungary, who has contributed so much to our knowledge of plant and soil nematodes of the world.

KEY TO INDIAN SPECIES OF CRICONEMELLA

Body annules less than 130; head end truncate ..... andrássyi n.sp.

Body annules more than 140; head end tapering and narrowly conoid..

.....parvula

GENUS DISCOCRICONEMELLA DE GRISSE & LOOF, 1965

De Grisse & Loof (1965) placed two species of Criconemoides (sensu lato) which had an oval distinctly set off cephalic disc on their lip regions in a new genus Discocriconemella. These species were D. limitenea and D. mauritiensis. Later, several species were added to this genus by Dieb & Jenkins (1966), De Grisse (1967 & 70), Krnjaic (1967), Heyns (1970), Luc (1970), Hoffman (1974), Choi & Geraert (1975), Sauer & Hinoto (1975), Pinochet & Raski (1976), Khan et al. (1976), Orton Williams (1979), etc. Luc (1970) transferred four of these species to Criconemoides. Loof & De Grisse (1973) shifted 2 species to Macroposthonia and one species to Nothocriconema, but brought Criconemoides colbrani to Discocriconemella. Khan et al. (1976) shifted D. recensi to the genus Madinema. The genus at present includes ten species and a new species is being described below obtained from the soil samples collected in Manipur. The diagnosis of the genus is given below.

Diagnosis: Macroposthoniinae. Body of nematodes small (0.20-0.50 mm), assuming a 'C'-shaped posture upon fixation. Body annules angular, posterior edges of annules finely but distinctly crenate, with many (about 20) anastomoses. Lip region distinctly set off, saucer-shaped in females, but conoid and with a typical elevation in males. Bursa absent, spicules short, stout and lateral fields with two incisures.

Type species:

Discocricconemella limitanea (Luc, 1959) De Grisse & Loof, 1965

Other species:

D. colbrani (Luc, 1970) Loof & De Grisse, 1973

D. caudaventer Orton Williams, 1979

D. discolobia (Diab & Jenkins, 1966) De Grisse, 1967

D. hercegovica Choi & Geraert, 1975

D. inaratus Hoffmann, 1974

D. mauritiensis (Williams, 1960) De Grisse & Loof, 1965

D. parvosa Sauer & Hinoto, 1975

D. replata Pinochet & Raski, 1976

D. retrovorsa Sauer & Hinoto, 1975

D. aquatica n. sp.

DISCOCRICONEMELLA AQUATICA N. SP.
(Fig. 31)

Diagnosis:

1) Paddy, Ulsan, Kangwon population (type):

Paratype females (5): L = 0.23-0.29 mm (0.26 mm); a = 6-8 (7); b = 2.6-2.9 (2.7); c = 11-15 (13); V = 88-90(89); VL/VB = 0.9-1.2 (1.1); total body annules = 91-110 (100); spear = 50-63 um (62 um).

Holotype female: L = 0.26 mm; a = 7; b = 2.8; c = 13; V = 8[illegible]; VL/VB = 1.1; total body annules = 110; spear = 62 um.

ii) Cressac, Kenchimur, Meniaur population:

Females (5): L = 0.21-0.26 mm (0.24 mm); a = 6-8 (7); b = 2.4-2.9 (2.5); c = 14-15 (14); V = 86-89 (88); VL/VB = 0.6-1.1 (1.0); total body annules = 90-102 (96); spear = 61-63 um (62 um).

Description:

Body stout, extremely ventrally curved upon fixation, tapering very little towards extremities. Body annules 3-4 um apart at midbody, 31-34 annules in oesophageal region, 45-64 annules from oesophago-intestinal junction to vulva, 4-6 annules from vulva to anus and 7-9 annules from anus to tail tip. The posterior margins of body annules finely crenate or wavey (fig. 31, E) with occasional anastomosing of annules. Lip region well set off, 4-5 um high, marked with two non-retrorse annules, first lip annule saucer-shaped with slightly anteriorly directed margins, 12-14 um wide, second lip annule with laterally directed margins, 14-15 um wide. First body annule retrorse, 15-17 um wide. Labial plates reaching second lip annule. Metenchium 50-54 um long or 81-85% of spear length. Basal knobs, of spear 7-9 um across, located on 23rd-26th body annules from anterior extremity. Orifice of dorsal oesophageal gland 2-3 um

from spear base. Prometacorpus 15-18 um wide and basal bulb 8-10 um wide at their widest. Nerve ring 78 um and oesophago-intestinal junction 82-99 um from anterior extremity. Excretory pore located on 30th-32nd annule from anterior extremity. Vulva closed, located on 11-13th annule and anus on 6 or 7th annule from posterior extremity. Vulva-anus 4-6 annules apart, the distance less than one vulval body-width. Tail conoid with bluntly rounded terminus, more than one anal body-width or nearly two times of vulva-anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of paddy, Oryza sativa from Ullou, Churachandpur, Road, Manipur.

Other habitat and locality: Soil around roots of grasses from Langthabal Kunja, Kanchipur, Manipur.

Type specimens: Collected by Dr. Dhanachand Chongtham in August 1978. Holotype on slide Discocriconemella aquatica n.sp./1; paratype females on slides Discocriconemella aquatica n. sp./2-6. Five females from Langthabal Kunja on slides Discocriconemella aquatica n. sp./7-9.

Differential diagnosis: Discocriconemella aquatica n. sp. comes close to D. limitanea (Luc, 1959) De Grisse & Loof, 1965 and

D. **replata** Pinochet & Raski, 1976. From D. **limitanea** it differs in the shape of lip region, in having a longer spear, anteriorly located excretory pore and a longer tail (spear = 45-53 um; Rex = 35-38; c = 17-30 in D. **limitanea**). From D. **replata** it differs in the shape of lip region, in the anterior location of excretory pore, vulva, more annules behind vulva (RV) and anus (Ran), and between vulva and anus (RVan), and a longer tail (Rex = 37-42; V = 93-95; RV = 7-8; Ran = 3-4; RVan = 3-4 and c = 20-26 in D. **replata**).

GENUS *XENOCRICONEMELLA* DE GRISSE & LOOF, 1965

De Grisse & Loof (1965) proposed for those species of *Criconemoides* (*sensu lato*) which had a long and rather flexible spear, the genus *Xenocriconemella*. Two species, *X. macrodora* and *X. juniperi* were included in the genus. However, Raski & Golden (1966) and Heyns (1970) considered the latter as a synonym of the former. Till to day, *X. macrodora* remains the only species under this genus and the same has also been recorded in the present work. The diagnosis of the genus is given below.

Diagnosis: Macroposthoninae. Small nematodes (0.18-0.32 mm), body open 'C' shaped upon fixation. Body anules angular, smooth or finely crenate, numbering 90-200. Submedian lobes present or absent. Ventral body contour not suddenly bent near vulva and the post-vulval body not tapering rapidly. Male with bursa and apparently two lateral lines.

Type and only species:

Xenocriconemella macrodora (Taylor, 1936) De Grisse & Loof, 1965

Syn. *X. juniperi* (Edward & Misra, 1964) De Grisse & Loof, 1965

XENOCRICONEMELLA LACTODORA (TAYLOR, 1936) DE GRISSE & LOOF, 1965

(Fig. 32)

Dimensions:

i) Ferns & Mosses, Mussoorie, Uttar Pradesh population:

Females (15): L = 0.24-0.29 mm (0.26 mm); a = 10-11 (10); b = 2.1-2.5 (2.3); c = 14-22 (18); V = 89-90(90); VL/VB = 1.2-1.3 (1.3); total body annules = 107-136 (128); RV = 13-17 (15); Ran = 8-11 (9); RVan = 6-8 (7); Rst = 43-51 (50); Roeso = 48-58 (56); Rex = 46-59; spear = 70-97 um (83 um); metenchium = 66-92 um.

ii) Wild plants, Mussoorie, Uttar Pradesh population:

Females (2): L = 0.22-0.26 mm; a = 8-10; b = 2.3-2.4; c = 16-26; V = 90; VL/VB = 1.2-1.3; total body annules = 122-128; RV = 11-12; Ran = 7-9; RVan = 3-4; Rst = 49; Roeso = 56; Rex = 59; spear = 92-97 um; metenchium = 85-91 um.

Habitats and localities: Soil around roots of i) ferns and mosses from Library Bazar, Mussoorie, Dehradun, Uttar Pradesh; ii) wild plants from Satsang Bhawan, Mussoorie, Dehradun, Uttar Pradesh.

Remarks: The present specimens show close resemblance to both X. macrodora and X. juniperi, justifying the synonymy of the

letter with the former as was done by Raski & Golden (1966) and Heyns (1970).

GENUS HEMICRICONEMOIDES CHITWOOD & BIRCHFIELD, 1957

The genus Hemicriconemoides was proposed by Chitwood & Birchfield in 1957. Goodey (1963) placed the genus in synonymy with Hemicycliophora but in the same year Siddiqi & Goodey revalidated it mainly because of the differences in the number of body annules and in the shape of spear knobs which are anchor-shaped in Hemicriconemoides and spheroid and sloping posteriorly in Hemicycliophora. They placed Hemicriconemoides in the subfamily Criconematinae Taylor, 1936, and Hemicycliophora in the subfamily Hemicycliophorinae Skarbilovich, 1959. Geraert (1966) raised Hemicycliophorinae to the rank of a family. Brzeski (1974) shifted Hemicriconemoides from Criconematinae to Hemicycliophorinae. Khan et al. (1976) agreed with Brzeski, and argued that Hemicriconemoides belonged to Hemicycliophorinae because of the presence of a sheath in the adult females and in the general resemblance of their body annules. Andrássy (1979) proposed anew subfamily Hemicriconemoidinae for this genus. Siddiqi (1980) raised Hemicycliophoridae to the rank of a superfamily, but has not included the Hemicriconemoidinae under Hemicycliophoroidea thereby agreeing with Andrássy (1979) in keeping Hemicriconemoidinae under Criconematoidea.

At present there are 33 species in this genus of which six species are known to occur in India, viz., H. birchfieldi,

H. coccophillus, H. litchi, H. mangiferae, H. mehdii, H. neobrachyurus. H. coccophillus and H. mangiferae are rather widely distributed in this country. During the course of this work soil samples obtained from Chamoli (Uttar Pradesh), Kutch (Gujarat) and Madras (Tamil Nadu) yielded three new species of this genus. These have been described and illustrated in the following.

Diagnosis: Hemicriconemoidinae. Females with extracuticular sheath, body annules not retrorse, smoothly, rounded and usually less than 200 in number. Basal knobs of spear typically anchor-shaped with margins anteriorly directed (except in H. strictathecatus and H. serratus n. sp.). Vulva posterior, sometimes with lateral flaps. Lateral fields in males present or absent. Spicules sickle-shaped. Bursa, if present, narrow and poorly developed.

Type species:

Hemicriconemoides wessoni Chitwood & Birchfield, 1957

Other species:

H. affinis Germani & Luc, 1970

H. alexis Vovlas, 1980

H. annulatus Pinochet & Raski, 1975

H. birchfieldi Edward, Misra & Singh, 1965

H. brachyurus (Loos, 1949) Chitwood & Birchfield, 1957

H. brevicaudatus Dasgupta, Raski & van Gundy, 1969

H. californianus Pinochet & Raski, 1975

H. chitwoodi Esser, 1960

H. cocophillus (Loos, 1949) Chitwood & Birchfield, 1957

H. communis Edward & Misra, 1964

H. gabrici (Yeates, 1972) Raski, 1976

H. gaddi (Loos, 1949) Chitwood & Birchfield, 1957

H. insignis Dasgupta, Raski & van Gundy, 1969

H. intermedius Dasgupta, Raski & van Gundy, 1969

H. kenyaensis Nakasono & Ichinohe, 1961

H. litchi Edward & Misra, 1964

H. mencifera Siddiqi, 1961

H. mehdii Suryawanshi, 1971

H. microdoratus Dasgupta, Raski & van Gundy, 1969

H. minutus Esser, 1960

H. neobrachyurus Dhanachand & Jairajpuri, 1980

H. nitida Pinochet & Raski, 1975

H. obtusus Colbran, 1962

H. parvus Dasgupta, Raski & van Gundy, 1969

H. paxilegus Vovlas, 1980

H. pseudobrachyurus De Grisse, 1964

H. saccharigo Heyns, 1970

H. strictathecatus Esser, 1960

H. taiwanensis Pinochet & Raski, 1975

H. ureshinoensis Yakoo, 1963

H. variendus Choi & Geraert, 1972

H. serratus n. sp.

H. indicus n. sp.

H. caudatus n. sp.

Two known species viz., H. coccophillus and H. mancifera are described in brief, while the three new species have been described in detail with suitable illustrations.

HEMICRICONEMOIDES COCCOPHILLUS (LOOS, 1949) CHITWOOD & BIRCHFIELD, 1957

(Fig. 33)

Dimensions:

i) Malta, Saharanpur, Uttar Pradesh population:

Females (4): L=0.38-0.46 mm (0.43 mm); a = 14-16 (15); b = 4.5-5.1 (4.9); c = 19-23 (20); V = 93-94(93); VL/VB = 1.3; total body annules = 106-118 (109); RV = 7-8 (8); RVan = 1; Rst = 15-18 (16); Roesc = 22-27 (25); Rex = 26-29 (27); spear = 49-52 um (52 um); metenchium = 42-49 um.

ii) Cuava, Saharanpur, Uttar Pradesh population:

Females (9): L = 0.38-0.48 mm (0.44 mm); a = 14-17 (16); b = 4.4-5.3 (5.0); c = 15-23 (18); V = 89-94(93); VL/VB = 1.3-1.7 (1.5); total body annules = 100-120 (119);

RV = 8-10 (9); Ran = 7-9(8); RVan = 1; Rst = 16-17 (17); Roeso = 22-26 (24); Rex = 21-31 (27); spear = 49-63 um (54 um); metenchium = 42-58 um.

iii) Flowering plants, Kathmandu, Nepal population:

Females (6): L = 0.40-0.48 mm (0.44 mm); a = 15-18 (17); b = 4.5-5.2 (4.9); c = 14-17 (15); V = 92-93(92); VL/VB = 1.4-1.7 (1.5); total body annules = 115-118 (117); RV = 10-11 (10); Ran = 7-10 (9); RVan = 1-3 (2); Rst = 15-17 (16); Roeso = 23-25 (24); Rex = 27-31 (29); spear = 53-58 um (56 um); metenchium = 48-53 um;

Habitats and localities: Soil around roots of i) malta, Citrus sinensis from L. R. Brothers' Nursery, Saharanpur, Uttar Pradesh; ii) guava, Psidium guayava from Company Gardens, Saharanpur, Uttar Pradesh; iii) flowering plants from Dhulikhel, Kathmandu, Nepal.

Remarks: Hemicriconemoides cocophilius is fairly widely distributed in India. Different populations show variations in the number of body annules, size of spear and in the shape of tail.

HEMICRICONEMOIDES MANGIFERAE SIDDIQI, 1961
(Fig. 34)

Dimensions:

i) Mango, Saharanpur, Uttar Pradesh population:

Females (2): L = 0.41-0.53 mm (0.47 mm); a = 16-22 (18); b = 4-6 (5); c = 16-27 (21); V = 86-94 (92); VL/VB = 2-3 (2); total body annules = 117-137 (122); RV = 11-13 (12); Ran = 7-10 (8); RVan = 3-4 (4); Rst = 18-21 (19); Roesc = 28-30 (29); Rex = 30-34 (33); Spear 57-66 um (60 um); metenchium = 49-57 um.

Males (2): L=0.37-0.41 mm; a = 18-24; b = ? ; c = 16-19; T = 36; spicules = 21-24 um; gubernaculum = 4-5 um; bursa = 25-26 um.

ii) Mango, Rishikesh, Uttar Pradesh population:

Females (4): L = 0.46-0.54 mm (0.50 mm); a = 16-19 (18); b = 4.6-5.1 (5.0); c = 18-22 (21); V = 92-93(91); VL/VB = 2-3 (2); total body annules = 124-146 (138); RV = 11-15 (13); Ran = 7-10 (8); RVan = 3-5 (4); Rst = 17-20 (19); Roesc = 25-33 (28); Rex = 31-37 (34); spear = 63-77 um (70 um); metenchium = 56-65 um.

iii) Mango, Meerut, Uttar Pradesh population:

Females (5): L=0.48-0.57 mm (0.52 mm); a = 18-20 (19); b = 4.4-5.3 (4.7); c = 16-24 (21); V = 90-93 (92);

VL/VB = 1.8–3.0 (2.3); total body annules = 133–145 (136); RV = 13–15 (14); Ran = 8–10 (9); RVan = 5; Rat = 19–20 (19); Rosso = 21–29 (27); Rex = 26–32 (29); spear =73–77 um (74 um); metenchium = 65–69 um.

Habitats and localities: Soil around roots of i) mango, Mangifera indica from Company Gardens, Saharanpur, Uttar Pradesh; ii) mango, Mangifera indica from Lakshman Jhula, Rishikesh, Saharanpur, Uttar Pradesh; iii) mango, Mangifera indica from campus A. S. Degree College, Mawana, Meerut, Uttar Pradesh.

Remarks: Hemicriconemoides mangiferae is one of the commonest species occurring in this country. It has a wide host range, but principally it is a parasite of fruit trees especially of the mangoes. The species shows variations in length, shape and number of body annules and in the length of spear and tail.

HEMICRICONEMOIDES SIMILATUS n. sp.
(Fig. 35)

Dimensions:

Paratype females (12): L=0.42–0.48 mm (0.45 mm); a = 15–18 (16); b = 3.9–4.3 (4.0); c = 18–28 (23); V = 90–93(92); VL/VB = 1.3–1.9 (1.9); total body annules = 115–128 (122); spear = 72–78 um (75 um).

Paratype males (2): L = 0.39–0.40 mm; a = 26–27; b = 5.0–5.2; c = 15–16; T = 28–33; spicules = 25 um; gubernaculum = 6 um.

Holotype female: L = 0.40 mm; a = 15; b = 3.9; c = 18; V = 92; VL/VB = 1.5; total body annules = 120; spear = 76 um.

Descriptions:

Female: Body slightly ventrally curved upon fixation, tapering towards extremities. Cuticular sheath tightly enclosing body. Body annules about 3 um apart at midbody, 29–37 annules in oesophageal region, 74–84 annules from oesophago-intestinal junction to vulva, 3–5 annules from vulva to anus and 6 or 7 annules from anus to tail tip. Annules with faint serration becoming more prominent behind vulva. Lip region angular, set off marked with two annules, first lip annule inverted saucer-shaped, 10–12 um wide, second lip annule 10–13 um wide. Labial framework strongly sclerotized. Metanchium 64–69 um long or 88–92% of spear length. Basal knobs of spear somewhat bluntly rounded and not typically anchor-shaped, 6–8 um across, located on 22nd–27th annule from anterior extremity. Orifice of dorsal oesophageal gland 4–6 um from spear base. Stomatocorpus 14–15 um wide and basal bulb 8–11 um wide at their widest. Nerve ring 90–103 um and oesophago-intestinal junction 103–118 um from anterior extremity. Excretory

pore located on 32nd-39th annule and hemizonid (n = 1) located on 31st annule from anterior extremity. Vulva located on 9-11th annule and anus on 5-7th annule from posterior extremity. Vulva-anus 3-5 annules apart, the distance less than one vulval body-width. Tail conoid nearly two anal body-widths or 2-3 times of vulva-anus distance long.

Male: Cuticular sheath absent. Lip region continuous with body. Lateral fields absent. Spear absent. Excretory pore 91-97 um from anterior extremity. Oesophegus degenerate. Spicules 25 um long, arcuate. Gubernaculum trough-shaped, 6 um long. Bursa absent. Tail bluntly-conoid, three anal body-widths long.

Type habitat and locality: Soil around roots of palm, Oreodora regia from Rajendra park, Bhuj, Kutch, Gujarat.

Type specimens: Collected in March 1979. Holotype on slide Guj/20 Hemicriconemoides serratus n. sp./1; paratype females on slide Guj/20 Hemicriconemoides serratus n. sp./2-4; paratype males on slide Guj/20 Hemicriconemoides serratus n. sp./5,6.

Differential diagnosis: Hemicriconemoides serratus n. sp. comes close to H. strictathecatus Esser, 1960, H. mangiferae Siddiqi, 1961 and H. alexia Vovlas, 1980. From H.strictathecatus it differs in having a shorter body, annules behind vulva with serrate margins, in having lesser annules on body, in the shape

of lip annules, in having a smaller spear and a differently shaped tail (L = 0.49-0.57 mm; annules not serrate; R = 136-147; lip annule simple, a canopy-like structure absent; spear 82-83 um and tail gradually tapering posteriorly and rounded at tip in H. strictutheratus). From H. mangiferae it differs in having serrate posterior margins of body annules behind vulva, a differently shaped lip region, in the shape of spear knobs, shape of tail, shape of apicules and in the absence of lateral fields and bursa (posterior margins of annules behind vulva not serrate; lip annule angular without any canopy-like structure; spear knobs anchor-shaped; tail elongate conoid, spicules with rounded head. Lateral fields and bursa present in H. mangiferae). From H. alexis it differs in having a smaller body, serrate and lesser annules on body behind vulva and anus, in shape of lip annule, posteriorly located vulva, a longer tail and in the presence of males (L = 0.48-0.56 mm; annules smooth; RV = 14-16; Ran = 9-10; lip region slightly set off with two rounded annules; elevated labial disc; V = 86-88; c = 12-17 and males not known in H. alexis).

HELICOTYLENCHUS INDICUS N. SP.
(Fig. 36)

Dimensions:

Paratype females (8): L = 0.39-0.43 mm (0.42 mm); a = 12-15 (14); b = 3.7-4.3 (4.0); c = 11.7-16.8 (13.5); V =

88-90 (89); VL/VB = 1.8-2.2 (1.9); total body annules = 112-120 (115); spear = 65-72 um (69 um).

Holotype female: L = 0.42 mm; a = 14.9; b = 3.9; c = 12.2; V = 86; VL/VB = 2.2; total body annules = 120; spear = 72 um.

Description:

Body slightly ventrally curved upon fixation, only a little tapering towards extremities. Cuticular sheath closely attached. Body annules 3-4 um apart at midbody, 29-33 annules in oesophageal region, 66-71 annules from oesophago-intestinal junction to vulva, 4-6 annules from vulva to anus and 9 or 10 annules from anus to tail tip. Lip region truncate-rounded, not set off 6-7 um high, marked with two annules (occasionally a third annule may also be observed); first lip annule 7-8 um wide, second lip annule 10-11 um wide. Labial sclerotization prominent, labial plates extending through first lip annule, reaching base of second lip annule (up to third lip annule in those where lip region comprised of three annules). Labial disc not elevated, in contour of first lip annule. Metenchium 59-64 um long or 89-91% of spear length. Basal knobs of spear anchor-shaped, 6-8 um across, located on 20th-23rd annule from anterior extremity. Orifice of dorsal oesophageal gland 4-6 um from spear base. Prometacorpus 13-15 um wide and basal bulb 8-10 um wide at their

widest. Nerve ring 92-93 um and oesophago-intestinal junction 103-108 um from anterior extremity. Excretory pore located on 29-34th annule and hemizonid 1 or 2 annule anterior to excretory pore. Vulva a wide opening, 3-4 um wide, located on 14-16th annule and anus on 9 or 10th annule from posterior extremity. Vulva-anus 4-6 annules apart, the distance nearly one or less than one vulval body-width. Tail conoid ending in an acute terminus or digitate in some specimens, with a ventral-bent near middle of its length, about two anal body-widths or 2-3 times of vulva-anus distence long.

Male: Not found.

Type habitat and locality: Soil around roots of malta, Citrus sinensis from orchards near Bhatta village, Chamoli, Uttar Pradesh.

Type specimens: Collected in September 1979. Holotype on slide CH/24 Hemicriconemoides indicus n. sp./1; paratype females on slides CH/24 Hemicriconemoides indicus n. sp./2-3.

Differential diagnosis: Hemicriconemoides indicus n. sp. comes close to H. gaddi (Loos, 1949) Chitwood & Birchfield, 1957 and H. insignis Dasgupta et al., 1969. From H. gaddi it differs in having smaller body, in the presence of the third (occasional) annule in lip region, anastomoses of annules, a smaller spear,

anteriorly located excretory pore and vulva, in the absence of spermatheca and shape of tail (L = 0.41-0.63 mm; a third lip annule never exists; anastomoses of annules absent; spear = 72-86 um; Ren = 36-38; V = 91-93; spermatheca present and tail bluntly conoid in M. caddi). From M. insignis it differs in having more annules behind vulva, anus, in presence of anastomoses of annules, in the shape of lip region with labial plates reaching 2nd or (occasionally 3rd) annule of lip region, in having first lip annule smaller than second lip annule, more posteriorly extending oesophagus and anteriorly located vulva and a longer tail (RV = 9-11; Ren = 6-8; anastomoses of annules absent; lip region truncate-conoid; labial plates covering only up to first lip annule; first lip annule bigger than second; Roesa = 29-31; V = 93-94; c = 23-27 in M. insignis).

MESOCRICONEMOIDES CAUDATUS N. SP.
(Fig. 37)

Dimensions:

Paratype females (9): L = 0.43-0.52 mm (0.48 mm); a = 16-20 (18); b = 5.0-5.3 (5.1); c = 15.3-16.2 (15.6); V = 91-93 (92); VL/VB = 1.3-1.9 (1.6); total body annules = 128-147 (133); spear = 54-57 um (55 um).

Holotype female: L = 0.52 mm; a = 17; b = 5.2; c = 15.5; V = 91; VL/VB = 1.8; total body annules = 135; spear = 56 um.

Description:

Body ventrally curved upon fixation, tapering a little towards extremities. Cuticular sheath loosely attached at lip region and vulva, forming a loose pouch at lip region. Posteriorly the sheath terminates behind anus leaving 4 or 5 terminal annules bare. Body annules 4-5 um apart at midbody, 27-30 annules in oesophageal region, 83-106 annules from oesophago-intestinal junction to vulva, 1 or 2 annules from vulva to anus and 11-13 annules from anus to tail tip. Annules smooth, rounded. Lip region rounded but truncate, 6-7 um high, marked with two annules, first lip annule 9-12 um wide bearing concave disc, second lip annule 10-13 um wide. First body annule 10-14 um wide, labial plates well developed extending up to the second lip annule. Metanchium 45-48 um long or 83-87% of spear length. Basal knobs of spear 7-9 um across, anchor-shaped located on 18th-21st annule from anterior extremity. Orifice of dorsal oesophageal gland 2-3 um apart from spear base. Prometacorpus 11-15 um and basal bulb 7-11 um wide at their widest. Nerve ring 72-85 um and oesophago-intestinal junction 88-94 um from anterior extremity. Excretory pore located on 27 or 28th annule, hemizonid on 20th annule (seen in one specimen) from anterior extremity. Spermatheca present, filled with sperms. Vulva located on 13 or 14th annule and anus on 11 or 12th annule from posterior extremity. Vulva-anus 1 or 2 annules apart, the distance one-fourth to one-fifth vulval body-

width. Tail elongate conoid with last few annules attenuated, unsheathed and slightly dorsally curved, nearly two anal body-widths or 5-6 times of vulva-anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of paddy, Oryza sativa from Madras, Tamil Nadu.

Type specimens: Collected in September 1980. Holotype on slide Mad/3 Hemicriconemoides caudatus n.sp./1; paratype females on slides Mad/3 Hemicriconemoides caudatus n.sp./2-4.

Differential diagnosis: Hemicriconemoides caudatus n.sp. is easily distinguished from the other species of the genus because of the presence of loose-sheath forming a lip-pouch and also in shape and nature of tail terminus. However, it comes close to H. coccophillus (Loos, 1949) Chitwood & Birchfield, 1957 and H.mehdii Suryawanshi, 1971. From H. coccophillus it differs in having more annules on body and behind vulva, a thin disc-like annule over the first lip annule, more anteriorly located excretory pore, in the absence of vulval flap and in the shape of tail (R = 99-120; RV = 9-11; lip region with two annules, first lip annules smaller than second; Rex = 29-32; vulval flap present; tail convex-conoid in H. coccophillus). From H. mehdii it differs in having a differently shaped lip region, anteriorly located excretory pore, in the absence of vulval flap and in the shape of tail (first lip annule bigger than second; Rex = 36-40; vulval flap present and tail conoid in H. mehdii).

KEY TO INDIAN SPECIES OF HEMICRICONEMOIDES

1. Cuticular sheath loose, envelops the lip region .... caudatus n. sp.
   Cuticular sheath not loose, not enveloping lip region 2

2. Spear knobs not exactly anchor-shaped but more or less rounded without forward directed processes 3
   Spear knobs anchor-shaped with forward directed processes.. 4

3. Spear knobs rounded without forward directed processes; body annules = 136-147; RV = 12-14 ..... strictathecatus
   Spear knobs with blunt processes, more or less rounded, body annules = 117-128; RV = 9-11 ..... serratus n. sp.

4. Lip region rounded, not set off; first lip annule angular directed outwardly; anastomoses of annules never present... ..... mencliferae

   Lip region rounded, set off partly; first lip annule not angular not directed outwardly; anastomoses of annule occasionally present 5

5. Spear 63-72 um long 6
   Spear 48-59 um long 7

6. Body length = 0.47–0.61 mm; body annules 140–162; vulval flap present..... *Neobrachyurus*

   Body length = 0.39–0.43 mm; body annules = 112–120; vulval flap absent ..... *indicus* n. sp.

7. Body annules = 130–150; c = 9, ... *mehdii*

   Body annules = 99– 120; c = 16–20; ..... *cocophillus*

Not included in key: i) *H. communis*, ii) *H. birchfieldi* and iii) *H. litchi* because the first one is a synonym of *H. cocophillus* and the other two of *H. mangiferae*.

GENUS HEMICYCLIOPHORA DE MAN, 1921

Hemicycliophora was proposed by De Man in 1921 on the basis of a single male specimen. Micoletzky (1925) proposed another genus Procriconema based on females only. Loos (1940) collected both the males and females of a species from the same locality, the males resembling Hemicycliophora the females Procriconema, and he accordingly came to the conclusion that Procriconema is a synonym of Hemicycliophora. Tarjan (1952) revised the genus and added several species. Thorne (1955) described 15 new species and gave a key to its species. New species were also added by the folloing authors: Jenkins & Reed (1964) two; Wu (1966) three; Loof (1968) seven; Loof & Heyns (1969) two; Germani & Luc (1973) four, etc. Brzeski(1974) reviewed the subfamily Hemicycliophorinae Skarbilovich, 1959 and also added some new species of this genus and provided a key to its species. Eroshenko (1976) reviewed the family Hemicycliophoridae and also gave a key for the identification of species of Hemicycliophora. From India, new species of this genus were described by Siddiqi (1961), Khan & Basir (1963), Husain & Khan (1967), Edward & Rai (1970), Misra & Edward (1971), Khan & Nanjappa (1972), Jairajpuri & Baqri (1973), Das & Shivaswamy (1976) and Ray & Das (1980), etc. Andrássy (1979) in the revision of Criconematinae has raised a new genus Colbranium for Hemicycliophora truncata Colbran, 1956 on the basis of set

off lip region. Siddiqi(1960) raised the family Hemicycliophoridae to a superfamily and has further splitted Hemicycliophora(sensu lato) into three genera: Hemicycliophora(sensu stricto), Acrofis and Aulosphora on the basis of the shape of spicules and elongation of anterior vulval lip. At present the superfamily Hemicycliophoroidea contains two families, viz.,Hemicycliophoridae and Caloosiidae. Under Hemicycliophoridae is included the subfamily Hemicycliophorinae. Hemicycliophorinae now consists of four genera, viz., Hemicycliophora, Aulosphora, Acrofis and Colbranium.

The genus Hemicycliophora(sensu stricto), at present consists of 71 species. Of those the following four species are known to occur in India: H. arcticaris, H. chirandri, H. sucenica, H. subscalica.

In the present work, the descriptions are provided of two new species, one from an altitude over 3000 m (Chamoli hills) and the other from the plains (Saharanpur, Uttar Pradesh) along with the redescription of H. chirandri. The diagnosis of the genus and a list of species is as follows:

Diagnosis: Hemicycliophorinae. Females 0.62-2.00 mm in length covered with an extra-cuticular sheath. Body annules coarse, not retrorse. Body just behind vulva deeply recessed. Lateral fields may or may not be present. Vulval lips modified, elongate but 1 as then three annules long, usually divergent. Female tail elongate-tapering, filiform, cylindrical or rarely

hemispherical. Spicules semi-circular. Penial tube well developed but less than body-width long, directed outward and forward, body just in front of penial tube recessed. Pre- and post-anal parts of bursa almost equal.

Type species:

Hemicycliophora typica De Man, 1921

Other species:

H. aberrans Thorne, 1955

H. andrássyi Brzeski, 1974

H. aquatica (Micoletzky, 1913) Loos, 1948

H. arcuata Thorne, 1955

H. arenaria Raski, 1958

H. arciensis Khan & Nanjappa, 1972

H. belemnia Germani & Luc, 1973

H. biloculata Colbran, 1969

H. brevicauda Sauer, 1958

H. brevis Thorne, 1955

H. californica Brzeski, 1974

H. chathami Yeates, 1978

H. chilensis Brzeski, 1974

H. conida Thorne, 1955

H. corbetti Siddiqi, 1980

H. dhirendri Husain & Khan, 1967

H. diolcogasia Germani & Luc, 1973

H. epicharia Raski, 1958

H. epicharoides Loof, 1968

H. eugeniae Khan & Basir, 1963

H. floridensis (Chitwood & Birchfield, 1957) Goodey, 1963

H. gracilis Thorne, 1955

H. halophila Yeates, 1967

H. hesperia Raski, 1958

H. iwia Brzeski, 1974

H. jugiandis Choi & Geraert, 1975

H. koreana Choi & Geraert, 1971

H. labiata Colbran, 1960

H. loofi Maas, 1970

H. lutosa Loof & Heyns, 1969

H. macrisathmus Loof, 1968

H. madagascariensis Germani & Luc, 1973

H. mettleri Jenkins & Reed, 1964

H. micoletzkyi Goffart, 1951

H. minora Wu, 1966

H. nana Thorne, 1955

H. natalensis Loof & Heyns, 1969

H. nigeriensis Germani & Luc, 1973

H. nortoni Brzeski, 1974

H. nucleata Loof, 1968

H. nyemata Schoemaker, 1968

H. obesa Thorne, 1955

H. obtusa Thorne, 1955

H. ovata Colbran, 1962

H. paryma Tarjan, 1952

H. pauciannulata Luc, 1958

H. perseca Monteiro & Lordello, 1978

H. pruni Kirjanova & Shagalina, 1974

H. raskii Brzeski, 1974

H. rittari Brzeski, 1974

H. rotundicauda Thorne, 1955

H. salicis Sofrygina, 1972

H. saueri Brzeski, 1974

H. shashorói Wu, 1966

H. shori Brzeski, 1974

H. signata Orton Williams, 1978

H. similis Thorne, 1955

H. spinosa Colbran, 1969

H. striaturata Germani & Luc, 1973

H. striatula Thorne, 1955

H. subcolica Jairajpuri & Baqri, 1973

H. tarjani Khan & Basir, 1963

H. tenuis Thorne, 1955

H. tessalata Sauer, 1958

H. thornei Cooday, 1963

H. transvalensis Heyns, 1962

H. trimeculum Loof, 1968

H. vidua Raski, 1958

H. vitensis Orton Williams, 1978

H. zuckermani Brzeski, 1974

H. cooki n. sp.

H. paraumbonica n. sp.

HELICOTYLENCHUS DIHYSTERA HUSAIN & KHAN, 1967
(Fig. 38)

Dimensions:

1) Botha orassum, University campus, Aligarh, Uttar Pradesh population:

Females (5): L = 0.62–0.76 mm (0.68 mm); a = 18–22 (20); b = 3.7–6.3 (5.5); c = 8.6–11.2 (9.9); V = 83–86 (85); VL/VB = 2.0–3.2 (2.8); total body annules = 198–204 (199); spear = 56–60 um (59 um).

11) Grazing, Kanpur, Uttar Pradesh population:

Females (5): L = 0.64–0.73 mm (0.68 mm); a = 18–30 (23); b = 5–6 (6); c = 8–10 (9); V = 83–85 (84); VL/VB = 2.8–3.2 (3.0); total body annules = 177–214 (186); spear = 52–59 um (57 um).

iii) Banana, Saharanpur, Uttar Pradesh population:

Females (12): L = 0.62-0.73 mm (0.67 mm); a = 19-27 (27); b = 5.5-6.2 (5.8); c = 6.9-11.0 (10.1); V = 83-85 (84); VL/VB = 2.6-3.2 (2.8); total body annules = 170-204 (198); spear = 56-60 um (58 um).

Male: L = 0.56 mm; a = 27.9; b = 7 ; c = 6.9; T = 24; spicules = 32 um; gubernaculum = 7 um; bursa = 34 um.

iv) Pumpkin, Allahabad, Uttar Pradesh population:

Female : L = 0.70 mm; a = 19.4; b = 6; c = 11.3; V = 86; VL/VB = 3; total body annules = 189 ; spear = 59 um.

Male: L = 0.52 mm; a = 26.9; b = 7 ; c = 10.8; T = 16; spicules = 39um; gubernaculum = 6 um; bursa = 38 um.

Descriptions:

Female: Body almost straight. Body annules 3-4 um apart, 31-40 annules in oesophageal region, 100-132 annules from oesophago-intestinal junction to vulva, 10-16 annules from vulva to anus and 19-30 annules from anus to tail tip. Lateral fields with one line (fig. 38, D). Lip region with two annules, first annule 12-13 um, second lip annule 15-16 um wide. Labial disc slightly elevated. Metenchium 41-50 um long

or 79-83% of spear length. Basal knobs of spear smoothly rounded, sloping, 3-4 um across, located on 16-19th annule from anterior extremity. Orifice of dorsal oesophageal gland 4-6 um from spear base. Prometacorpus 14-16 um wide. Nerve ring 91-108 um and oesophago-intestinal junction 106-130 um from anterior extremity. Excretory pore 5-7 annules posterior to oesophago-intestinal junction, located on 38th-42nd annule from anterior extremity. Hemizonid 1 or 2 annules wide located on 34-39th annule from anterior extremity or 2-4 annules anterior to excretory pore. Vulva located on 30th-43rd annule and anus on 19-30th annule from posterior extremity. Anterior vulval lip 2 annules long. Vulve-anus 10-16 annules apart or more than one vulval body-widths. Tail elongate conoid 3-4 anal body widths or two times of vulva-anus distance long.

Male: Body cuticle finely striated. Cuticular sheath absent. Striae 1.5-2.0 um wide. Lateral fields marked with two incisures (fig. 38, 1), one-fourth to one-fifth of body-width wide. Lateral incisures traversed by transverse striae. Spear and oesophagus degenerate. Excretory pore behind hemizonid, 83-113 um and hemizonid 2-3 annules wide, 76-105 um from anterior extremity. Nerve ring one and half body widths anterior to hemizonid. Spicules greatly curved, semi-circular. Gubernaculum trough-shaped. Bursa originates above the level of spicules and terminates about four anal body-widths above the

tail tip. Tail five anal body-widths long.

Habitats and localities: Soil around roots of i) motha grasses, Cyperus rotundus from lawns of Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh; ii) grapvine, Vitis vinifera from Botanical Gardens, Chandra Shekhar Azad University of Agric. & Tech., Kanpur, Uttar Pradesh; iii) banana, Musa paradisiaca from L. R. Brothers' Nursery, Saharanpur, Uttar Pradesh; iv) pumpkin, Cucurbita pepo from orchard, Allahabad Agricultural Institute, Allahabad, Uttar Pradesh.

Remarks: Samples from different localities yielded populations of H. dhirendri which fit the description of the species as given by Husain & Khan (1967) and also with that of H. demani Edward & Rai, 1970. The type specimens of H. demani obtained from Dr. J. C. Edward were studied and found very similar to that of H. dhirendri. The latter was collected from its type locality. The present study reveals that H. demani is a synonym of H. dhirendri. Since the description of H. dhirendri was inadequate in many respect, it was considered useful to re-describe the species along with males. H. dhirendri comes close to H. labiata Colbran, 1960 in many characters like the length of body (0.70-0.86 mm), number of body annules (181-217), annules behind vulva to tail tip (39-45), anus to tail tip (27-30) and from anterior extremity to excretory pore

(34-40) and the length of spear (62-67 um). However it differs from H. labiata in having a single line in lateral field and in the absence ofacevity in the spear knobs (lateral fields with one line accompanied by two faint longitudinal lines and distinct cavity present in the spear knobs in H. labiata).

HELICOTYLENCHUS OKOASI n. sp.
(Fig. 39)

Dimensions:

Paratype females (14): L = 0.93-1.70 mm (1.04 mm); a = 21-30 (26); b = 5.3-8.7 (6.3); c = 7-8 (7); V = 80-85 (82); VL/VB = 4-6 (5); total body annules = 311-431 (334); spear = 92-100 um (98 um).

Holotype female: L = 1.07 mm; a = 27; b = 6.3; c = 7; V = 81; VL/VB = 5.5; total body annules = 338; spear = 98 um.

Description:

Body ventrally curved upon fixation. Outer cuticle loosely attached at tip region and vulva. Body annules 3 um apart at midbody. 52-72 annules in oesophageal region, 183-240 annules from oesophago-intestinal junction to vulva, 16-24 annule from vulva to anus and 50-76 annules from anus to tail tip. Lateral fields one-fifth body-width wide with two bands each having ovate ornamentations (fig. 39, F). Lip region rounded, 16-17 um wide

marked with three annules, smooth, narrower than body annules. En face showing slightly elliptical labial disc and lips. Amphidial apertures oval in shape. Metarchium 79-84 um or 82-85% of spear length, often slightly ventrally curved. Basal knobs of spear 6-7 um across, located on 29-35th annule from anterior extremity. Orifice of dorsal oesophageal gland at 3-5 um from spear base. Promotecorpus 17-18 um wide and basal bulb 5-8 um at their widest. Nerve ring 136-154 um and oesophago-intestinal junction 106-189 um from anterior extremity. Excretory pore below oesophago-intestinal junction, located on 67th-71st annule and hemizonid 2 or 3 annules wide, located on 61-71st annule from anterior extremity. Vulva with modified lips, less than 3 body annules long, located on 61st to 92nd annule and anus on 37-76th annule from posterior extremity. Vulva-anus, 16-24 annules apart or distance between vulva and anus more than one vulval body-width. Tail elongato-conoid, 4-6 anal body-widths or nearly three times of vulva-anus distance long. Hyaline part of tail one-half anal body-width long.

Male: Not found.

Type habitat and locality: Soil around roots of peach, Prunus persica from Company Gardens, Saharanpur, Uttar Pradesh.

Type specimens: Collected in February 1970. Holotype on slide

CR⁶/100 Hemicycliophora cesari n. sp./1; paratype female on slide CR⁶/100 Hemicycliophora cesari n. sp./2-9.

Differential diagnosis: Hemicycliophora cesari n. sp. comes close to H. conida Thorne, 1955 and H. saueri Brzeski, 1974. From H. conida it differs in having more annules on body, vulva to tail tip, more vulva-anus distance, a different structure of lateral fields, in the absence of longitudinal scratches in having three annules on lip region and in the lengt and shape of tail (R = 175-267; RV = 35-51; vulva-anus distance less than one vulval body-width; lateral fields with break of striae; longitudinal scratches present; lip annules two; tail 3-4 anal body-width or more than four times of vulva-anus distance in H. conida). From H. saueri it differs in the absence of anastomoses of annules on body, different structure of lateral fields, in the shape of lip region, location of hemizonid and vulva, in having more vulva-anus distance and in the lengt and shape of tail (anastomoses of annules present; lateral fields marked with two rows of ornamentations; lip region with three annules separated from body by a shallow constriction; hemizonid anterior to oesophago-intestinal junction; V = 88-91; vulva-anus distance less than half vulval-body width; tail nearly t ree anal body-widths or seven times of vulva-anus distance in H. saueri).

HELICYLLIOTHERA PARAGUAYLICA N. SP.
(Fig. 40)

Dimensions:

Paratype females (6): L = 0.93-0.99 mm (0.96 mm); a = 21-24 (22); b = 5.9-6.4 (6.2); c = 7-8 (7); V = 82-84 (83); VL/VB = 3.4-4.6 (4.3); total body annules = 190-214 (204); spear = 78-85 (83 um).

Holotype female: L = 0.99 mm; a = 24; b = 6; c = 7; V = 82; VL/VB = 4.6; total body annules = 197; spear = 85 um.

Description:

Body slightly ventrally curved upon fixation, tapering less towards anterior and more towards posterior extremity. Outer cuticle loosely attached only at lip region and vulva. Body annules averaging 3 um apart at midbody, 33-42 annules in oesophageal region, 117-133 annules from oesophago-intestinal junction to vulva, 8-12 annules from vulva to anus and 27-33 annules from anus to tail tip. Lateral fields absent, annules smooth only anastomoses of annules present. Lip region continuous, 15-18 um wide, marked with three smooth annules, smaller than body annules. Labial framework moderately developed, labial plates extending up to last lip annule. Metenchium 64-70 um or 82-85% of spear length. Basal knobs of spear 5-6 um across, located on 19 or 20th annule from anterior

extremity. Orifice of dorsal oesophageal gland 3-4 um from spear base. Prometacorpus 13-15 um wide and basal bulb 7-10 um wide at their widest. Nerve ring 135-139 um and oesophago-intestinal junction 150-162 um from anterior extremity. Excretory pore below oesophago-intestinal junction, located on 38-44th annule from anterior extremity. Vulva located on 38th-41st annule with vulval lip which is 3 or less than 3 body annules long; anus located on 27th-33rd annule from posterior extremity. Vulva-anus, 8-12 annules apart, the distance nearly one vulval body-width. Tail elongate-conoid, 3-4 anal body-widths long or two-three times of vulva-anus distance long.

Male: Not found.

Type habitat and locality: Soil around roots of grasses and waterweeds, Chancharia village, Govinda Ghat, Chamoli, Utter Pradesh.

Type specimens: Collected in September 1979. Holotype female on slide CH/58 Hemicycliophora paraubeolica n. sp./1; paratype females on slide CH/58 Hemicycliophora paraubeolica n. sp./2-4.

Differential diagnosis: Hemicycliophora paraubeolica n. sp. comes close to H. arvicensis Khan & Nanjappa, 1972 and H. subeolica Jairajpuri & Bagri, 1973. From H. arvicensis it differs in having a longer and wider body, lesser number of body annules, anastomoses of annules present and lesser number of

annules behind anus to tail tip (L = 0.73-0.92 mm; a = 25-35; R = 409-450; anastomoses absent; Ran = 70-98 in H. argiensis). From H. subcelica it differs in having a smaller body, lesser number of annules on body, in the presence of anastomoses of annules and a smaller spear (L = 1.04-1.1 mm; R = 225-245; anastomoses of annules absent; spear = 89-99 um in H. subcelica).

KEY TO INDIAN SPECIES OF HEMICYCLIOPHORA

1. Lateral fields present 2
   Lateral fields absent 4

2. Lateral fields with one incisure; spear 52-60 um long .....
   ..... chirendri
   Lateral fields with two incisures; spear 70-100 um long ...
   3

3. Lateral fields with two incisures bearing two rows of ovate ornamentations; RV = 61-92 ..... cocari n. sp.
   Lateral fields with two incisures, without any ovate orna - mentation; RV = 117 ..... eugeniae

4. Body annules = 400-450; RV = 107-140; body length = 0.73 - 0.92 mm ..... argiensis
   Body annules = 190-245; RV = 37-47; body length = 0.93 - 1.1 mm 5

5. Spear 78-85 um long; body annules = 190-214; body length = 0.93-0.99 mm ..... peresubeclica n. sp.

   Spear 87-99 um long; body annules = 225-245; body length = 1.04-1.1mm..... subeclica

Siddiqi (1980) proposed this genus to accommodate those species of Hemicycliophorinae which have modified lips and U-shaped or hooked spicules. He shifted five species of Hemicycliophora (sensu lato) to this genus. The diagnosis of the genus is as follows:

Diagnosis: Hemicycliophorinae. Female 0.8-2.0 mm long, enclosed in an extra-cuticular sheath. Body annules coarse, rounded, not retrorse. Body just behind vulva slightly recessed. Vulval lips elongated, over three body annules long, almost parallel and directed backward. Tail elongate, tapering. Spicules often very long (about 100 um or more), U-or hook-shaped. Penial tube over one body width long, directed forward and often touching ventral body surface. Body just in front of penial tube not deeply recessed. Bursa mostly pre-anal with pre- and post-anal parts in ratio of 3-4:1.

Type species:

Aulosphora penetrans (Thorne, 1955) Siddiqi, 1980

Other species:

A. dahomensis (Germani & Luc, 1976) Siddiqi, 1980

A. indica (Siddiqi, 1961) Siddiqi, 1980

A. oostenbrinki (Luc, 1958) Siddiqi, 1980

Δ. *semeni* (Das & Shivaswamy, 1977) Siddiqi, 1980

Δ. *utkali* (Ray & Das, 1980) n. comb.

In the above, *Hemicyclicphora utkali* Ray & Das, 1980 described from Koraput, Orissa has been shifted to *Aulacphora*. Δ. *indica* and Δ. *semeni* also were described from India, but originally as species of *Hemicyclicphora*. In the present work the following two species have been recorded: *Aulacphora coetzeebrinki* and Δ. *penetrans*. The former has been collected from many localities. Both species have been recorded for the first time from India.

AULACPHORA COETZEEBRINKI (LUC, 1958) SIDDIQI, 1980
(Fig. 41)

Dimensions:

1) *Indian redwood, Nainital, Uttar Pradesh population:*

Females(4): L = 0.86–1.04 mm (0.97 mm); a = 24–29 (27); b = 6–7 (7); c = 7–9 (8); V = 80–82 (81); VL/VB = 4.9–6.9 (5.6); total body annules = 348–392 (372); RV = 91–101 (94); Ran = 63–85 (79); RVan = 16–28 (22); Rat = 27–29 (28); Roeso = 51–57 (54); Rex = 61–67 (64); spear = 74–77 um (76 um); metarchium = 61–63 um.

ii) Wildplants, Kathgodam, Nainital, Uttar Pradesh population:

Females (13); L = 0.70-0.96 mm (0.84 mm); a = 20-27 (24); b = 5.3-7.0 (6.4); c = 5-7 (6); V = 74-81 (77); VL/VB = 5.2-6.5 (5.9); total body annules = 279-307 (293); RV = 86-88 (87); Ran = ? ; RVan = ? ; Rst = 30; Roeso = 52-55 (54); Rex = 56-62 (59); spear = 67-69 um (68 um); metenchium = 54-55 um.

iii) Banana, Baroda, Gujarat population:

Females (4); L = 1.01-1.09 mm (1.05 mm); a = 21-28 (24); b = 7; c = 6-7 (7); V = 70-80 (76); VL/VB = 5-8 (6); total body annules = 322-337 (330); RV = 66-79(75); Ran = 45-51 (51); RVan = 21-28 (24); Rst = 23-29 (26); Roeso = 40-52 (48); Rex = 46-60 (54); spear = 76-81 um (78 um); metenchium = 63-67 um.

Habitats and localities: Soil around roots of i) Indian redwood plant, Dalbergia sissoo from Pantnagar, Nainital, Uttar Pradesh; ii) wild plants from Kathgodam, Nainital, Uttar Pradesh; iii) banana, Musa paradisiaca from University Campus, Baroda, Gujarat.

Remarks: Aulacorhora coetzenbrinki was described by Luc (1958) from Ivory Coast. Brzeski (1974) collected it from Nigeria. The present specimens were collected from different altitudes

varying from 500-2000 m. The dimensions of these specimens agree with those given by Brzeski (1974). However, they show variations in the length of body, number of body annules and in length of spear. This species is recorded for the first time from India.

AULOSPHORA PENETRANS (THORNE, 1955) SIDDIQI, 1980

(Fig. 42)

Dimensions:

Females (7): L = 0.81-0.86 mm (0.84 mm); a = 19-22(21); b = 5.1-5.9 (5.6); c = 8-9 (8); V = 83-86 (84); VL/VB = 3.4-3.7 (3.5); total body annules = 230-238 (234); RV = 42-45(43); Rm = 27-35 (30); RVm = 10-15 (13); Rst = 21-25 (23); Rodo = 41-44 (43); Rex = 44-48 (46); spear = 74-77 um (75 um); metanchium = 60-63 um.

Habitat and locality: Soil around roots of wild trees from Kapulkundu, Nilgris, Tamil Nadu.

Remarks: Thorne (1955) described Hemicycliophora penetrans which was transferred to Aulosphora by Siddiqi (1980). The present specimens conform well with those redescribed by Brzeski (1974) except for having lesser number of body annules, anteriorly located excretory pore, lesser VL/VB and a longer

tail (R = 260-270; Rex = 49-52; VL/VB = 5.3-7.0 and c = 12-14 after Mrzoski).

KEY TO INDIAN SPECIES OF ANGUSTORA

1. Spear 130-134 um long; sheath annules not bearing longitudinal lines ..... cemani
   Spear 66-86 um long; sheath annules bearing longitudinal lines 2

2. Body annules = 230-270 ..... penetrans
   Body annules = 279-392 3

3. Vulval lip less than 5 body annules long; lip region marked with prominent sleeve of sheath ..... costenbrinki
   Vulval lip over 8 body annules long; lip region without any sleeve of sheath 4

4. Lip region with two annules; lateral fields with three incisures and longitudinal lines outside lateral fields .....
   ..... indica
   Lip region with three annules; lateral fields without incisures, only 40 longitudinal lines forming tra ezoidal blocks
   ..... utkali

GENUS *Caloosia* SIDDIQI & GOODEY, 1964

The genus *Caloosia* was erected by Siddiqi & Goodey in 1964. They transferred *Hemicycliophora longicaudata* Loos, 1948 and *Hemicycliophora longicaudata* of Siddiqi, 1961 (which Siddiqi & Goodey, 1964 named as *Caloosia paralongicaudata*) to this genus because of the absence of the cuticular sheath and males with almost straight spicules. Mathur *et al*., (1969) added two more species to it. Brzeski (1974) while reviewing *Hemicycliophora* and *Caloosia* transferred *Hemicycliophora nudata* Colburn, 1963 and *H. paradoxa* Luc, 1958 to *Caloosia*. Rao & Mohandas (1976) described *C. heterocephala* from rice fields in Cuttuck, Orissa. Ray & Das (1978) have splitted the genus *Caloosia* by proposing a new genus, *Hemicaloosia* for those species of *Caloosia* (*sensu lato*) in which females and juveniles were covered by a thin membranous cuticular sheath, which was thinner than the body cuticle and closely adpressed to the body, cuticle usually not folded between annules and the lateral fields marked by two incisures. They shifted *C. nudata* and *C. paradoxa* to this new genus. A new species of *Hemicaloosia*, *H. luci* was described by Dhanachand & Jairajpuri (1980). New species of *Caloosia* were described by Khan *et al*. (1979), Khuhro & Sanwal (1979), Chawla & Sanathanan (1980), Ray & Das (1980), etc. Siddiqi (1980) recognized *Caloosia doloresdi* Loos, 1970 as species of *Hemicaloosia*, re-grouped the species under *Caloosia* and *Hemicaloosia* along with their amended diagnoses and keys to their

species. At present under Calcensis are included 10 species, all of which are found in this country.

In the present work two species of this genus, viz., C. indica and C. parelongicaudata were collected from several localities in India. Males were found for both the species. The list of nominal species and the diagnosis of the genus is given hereunder:

Diagnosis: Calcensiinae. Body of both sexes elongate, body cuticle thick, strongly annulated and folded between annules, extra-cuticular thin sheath absent. Lip annules separate. Amphids funnel-shaped, apertures slit-like. Lateral fields absent. Males with lip region, not marked by an interruption of body annulation, bursa present, spicules straight and gubernaculum present. Tail in both sexes elongate-filiform, male tail shorter than that of females.

Type species:

Calcensis longicaudata (Loos, 1948) Siddiqi & Goodey, 1964

Other species:

C. brevicaudata Khan, Chawla & Saha, 1979

C. exilis Luthur, Khan, Land & Prasad, 1969

C. heterocephala Rao & Mohandas, 1976

C. indica Chawla & Sanathanam, 1980

C. peralonicauda Siddiqi & Goodey, 1964

C. perlong Khan, Chawla & Saha, 1979

C. perapexi Phukan & Sanwal, 1979

C. pexi Mathur, Khan, Nand & Prasad, 1969

C. triannulata Ray & Das, 1980

CRICONEMA INDICA CHAWLA & SAHAHANNN, 1980

(Fig. 43)

Dimensions:

Females (2): L = 1.4-1.6 mm; a = 34-35; b = 9.0-9.2; c = 3.6-4.6; V = 67-70; VL/VB = 24-41; total body annules = 257-356; RV = 134-139; Ran = 116-120; RVan = 18-19; Rst = 18-19; Roeso = 30-31; Rex = 38-40; spear = 86-93 um; metenchium = 66-75 um.

Juveniles (3): L = 1.0-1.1 mm; a = 39-44; b = 7; c = ? ; total body annules = 350-368; Rst = 22-25; Roeso = 40-45; Rex = 42; spear = 73-78 um.

Males (2): L = 1.3 mm; a = 37; b = 8.8-9.2; c = 4.0-4.5; T = 26; spicules = 50-53 um; gubernaculum = 11-14 um; bursa = 84-109 um.

Habitat and locality: Soil around roots of catechus, Acacia catechu from Mirzapur, Uttar Pradesh.

Remarks: Present specimens closely resemble the type population described by Chawla & Sanathanam (1980) except that they differ only in having more annules in oesophageal region and larger spicules and gubernaculum (Roesc = 32-40; spicules = 45 um and gubernaculum = 10 um in C. indica by Chawla & Sanathanam,1980).

CRACOSIA PARALONGICAUDATA SIDDIQI & GOODEY, 1964
(Fig. 44)

Dimensions:

i) Paddy, Madras, Tamil Nadu population:

Females (4): L = 0.83-0.92 mm (0.90 mm); a = 24-26 (25); b = 6.5-7.9 (7.2); c = 4.8-5.8 (5.2); V = 73-76 (75); VL/VB = 6.5-8.5 (7.3); total body annules = 232-236 (234); RV = 78-90 (84); Ran = 63-75 (71); RVan = 14-17 (15); Rst = 16-18 (17); Roesc = 27-32 (30); Rex = 32-34; spear = 69-74 um (71 um); metenchium = 54-57 um.

ii) Wild trees, Malayarum, Kerala, population:

Females (5): L = 1.0-1.02 mm (1.0 mm); a = 32-33 (32); b = 7.0-7.8 (7.4); c = 8.0-8.4 (8.2); V = 76-80; VL/VB = 6.7-8.8 (7.3); total body annules = 187-231 (209); RV = 70-78 (76); Ran = 55-63 (59); RVan = 15; Rst = 19-20 (19); Roesc = 33-35 (34); Rex = 35; spear 72-74 um (73 um); metenchium = 56-57 um.

Male: L = 0.94 mm; a = 45; b = ? ; c = 7; T = 13; spicule = 45 um; gubernaculum = 9 um; bursa = 76 um;

Habitats and localities: Soil around roots of i) paddy, Oryza sativa from Paddy fields near rice factory, Madras, Tamil Nadu; ii) wild trees from Mukkali, Palakkad, Kerala.

Remarks: Both the populations of Caloosia paraloncicaudata are in general agreement with that described by Siddiqi & Goodey(1964) and Brzeski (1974).

KEY TO INDIAN SPECIES OF CALOOSIA

1. Lip region marked with three annules ..... triannulata
   Lip region marked with two annules 2

2. Body annules = 255-356 3
   Body annules = 150-250 4

3. Vulva at 78-80% of body length ..... exilis
   Vulva at 67-70% of body length ..... indica

4. Body annules = 155-169; excretory pore anterior to oesophago intestinal junction..... heterocephala
   Body annules = 190-250; excretory pore below oesophago intestinal junction 5

5. Both the lip annules wider, first anteriorly saucered, second posteriorly hollowed 6

Both lip annules wider, directed laterally and outwardly ... . **longicaudata**

6. Body length 0.67–0.78 mm ..... **paul**

Body length 0.86–1.04 mm ..... **paralongicaudata**

Note: Calcousia paraxaxi Chukan & Senval, 1979 fits well with the measurements of C. longicaudata and may possibly be its synonym.

GENUS PARATYLENCHUS MICOLETZKY, 1922

In 1922, Micoletzky found a nematode in the sandy soils of marshland in Rumania and named it as Paratylenchus bukovinensis. Cobb (1923) described P. nanus and published a note on a sexually immature form which was named P. arcuatus. In 1931, P. bonneiensis was described by Bally & Reydon. Filipjev (1934) placed this genus in the subfamily Hoplolaiminae. Skarbilovich (1947) supported the views of Filipjev, but Taylor (1936) brought the genus to the subfamily Criconematinae. Thorne (1949) raised Criconematinae to the level of a family and also proposed the subfamily Paratylenchinae for the placement of Paratylenchus and Cacopaurus Thorne, 1943. In 1960, Terjan reviewed the genus along with the descriptions of two new species, and a key to its valid species. Raski (1962) proposed a new genus Gracilacus and transferred all those species of Paratylenchus (sensu lato) bearing a spear longer than 40 um, excretory pore anterior to nerve ring, and females plump to obese at maturity. Brzeski (1963) and Siddiqi & Goodey (1964) synonymized Gracilacus with Paratylenchus. Geraert (1964) reviewed the genus Paratylenchus and recognized 34 species under it. Wouts (1966) proposed a key to its species, while Solovyeva (1972) and Raski (1975) reviewed the genus. The latter author published his work in three parts, the first and the second parts dealt with Paratylenchus, whereas the third part

covered Gracilacus. He provided keys to species of both these genera. This being the most recent, excellent and authoritative account on these two closely related genera. The diagnosis of Paratylenchus and list of species under it is as follows.

Diagnosis: Paratylenchinae. Body short (< 0.50 mm), elongate cylindrical. Body cuticle finely striated without ornamentations. Spear under 40 um in length. Excretory pore commonly in the vicinity of the basal bulb. Body posterior to vulva elongate. Males slender, spear absent. Bursa absent.

Type species:

Paratylenchus bukovinensis Micoletzky, 1922

Other species:

P. acanthus Raski, 1975

P. alleni Raski, 1975

P. aquaticus Merny, 1966

P. baldaccii Raski, 1975

P. bonachicus Daily & Reydon, 1931

P. breviculus Raski, 1975

P. colbrani Raski, 1975

P. coronatus Colbran, 1965

P. dianthus Jenkins & Taylor, 1956

P. elachistus Steiner, 1949

P. **goldeni** Raski, 1975

P. **halophilus** Routs, 1966

P. **hamatus** Thorne & Allen, 1950

P. **holdemani** Raski, 1975

P. **humilis** Raski, 1975

P. **italiensis** Raski, 1975

P. **leiodermus** Raski, 1975

P. **lenidus** Raski, 1975

P. **leptus** Raski, 1975

P. **lobaticaudatus** Raski, 1975

P. **macrosoma** Andrássy, 1959

P. **microdorus** Andrássy, 1959

P. **minusculus** Merjan, 1960

P. **minutus** Raski, 1975

P. **morius** Yakoo, 1970

P. **nainianus** Edward & Misra, 1963

P. **nanus** Cobb, 1923

P. **navadus** Khan, Prasad & Mathur, 1967

P. **neoambicephalus** Germert, 1965

P. **neonanus** Mathur, Khan & Prasad, 1967

P. **obtusicaudatus** Raski, 1975

P. **paramorovi** Bagaturia & Solovyova, 1972

P. **parlatus** Raski, 1975

P. **penticus** Thorne & Malek, 1968

P. projectus Jenkins, 1956

P. pseudouncinatus Bhukan & Sanwal, 1979

P. salubris Raski, 1975

P. sericeudatus Raski, 1975

P. similis Khan, Prasad & Mathur, 1967

P. tetoso Wu & Townshend, 1973

P. tenuicaudatus Wu, 1961

P. uncinatus Samibaeva, 1966

P. vandenbrandi De Grisse, 1962

P. variabilis Raski, 1975

P. verruculatus Wu, 1962

P. vexens Thorne & Malek, 1968

The genus Paratylenchus, at present, comprises 47 species described from all over the world. From India, the following 7 species were already known: P. dianthus, P. lenidus, P. nainianus, P. navedus, P. neonanus, P. pseudouncinatus and P. similis. In the present work four species of this genus were recorded viz., P. boeckianus, P. halorhilus, P. minusculus and P. nainianus. The first three being new records from India.

PARATYLENCHUS BOECKIANUS BALLY & REYDON, 1931
(Fig. 45)

Dimensions:

Females (9): L = 0.22-0.27 mm (0.25 mm); a = 20-31(23); b = 3.4-4.2 (3.9); c = 9.5-22.4 (13.4); V = 82-86 (83);

VL/VB = 3.8-5.8 (4.8); spear = 16.5-22.5 um (19.5 um); metenchium = 12-17 um; excretory pore = 52-66 um (58 um).

Habitat and locality: Soil around roots of mulberry, Morus indica from Rajpur, Dehradun, Utter Pradesh.

Remarks: Baily & Reydon (1931) had described Paratylenchus baeckianus from Indonesia and Java islands. The present specimens fit well with the original description except that they have a narrower body (a = 17-19 in P. baeckianus after Baily & Reydon, 1931).

PARATYLENCHUS HELOPHILUS WOUTS, 1966
(Fig. 46)

Dimensions:

Females (4): L = 0.33-0.37 mm (0.35 mm); a = 23-27(25); b = 3.5-4.2 (3.9); c = 9.2-13.8 (11.3); V = 83-86 (84); VL/VB = 4.6-5.0 (4.8); spear = 27-31 um (29 um); metenchium = 17-23 um; excretory pore = 84-94 um (90 um).

Habitat and locality: Soil around roots of peach, Prunus Persica from Kundighat, Mussoorie, Dehradun, Utter Pradesh.

Remarks: Paratylenchus helophilus was first described from New Zealand by Wouts (1966). The present specimens are similar except for some minor differences in the nature of elongation of

oesophegus, anterior location of vulva and in the shape of tail (b = 4.1-4.6; V = 76-80; and tail terminus digitate in P. halophilus after Wouts, 1966).

PARATYLENCHUS MINUSCULUS TARJAN, 1960
(Fig. 47)

Dimensions:

Females (3): L = 0.26-0.30 mm (0.27 mm); a = 23-26 (25); b = 3.7-4.1 (4.0); c = 8.2-13.4 (n = 2); V = 80-84 (82); VL/VB = 4.8-5.2 (5); spear = 23.8-26.6 um (24.7 um); metenchium = 16-19 um; excretory pore = 59-63 um (61 um).

Habitat and locality: Soil around roots of peach, Prunus persica from Company Gardens, Mussoorie, Dehradun, Uttar Pradesh.

Remarks: Paratylenchus minusculus was described by Tarjan(1960) from the State of Florida, U.S.A. The present specimens conform well with those described by him.

PARATYLENCHUS NAINIANUS EDWARD & MISRA, 1963
(Fig. 48)

Dimensions:

Females (4): L = 0.28-0.33 mm (0.30 mm); a = 20-27 (23); b = 3.7-4.1 (3.9); c = 9.7-12.2 (10.9); V = 78-83 (81);

VL/VB = 4.0-5.8 (5.0); spear = 19-24 um (21 um); metenchium = 13-15 um; excretory pore = 65-69 um (67 um).

Habitat and locality: Soil around roots of palm, Borassus flabellifer from Aslali, Ahmedabad, Gujarat.

Remarks: It is fairly widely distributed species in India. The above specimens closely resemble the type specimens as described by Edward & Misra (1963).

KEY TO INDIAN SPECIES OF PARATYLENCHUS

1. Spear 11-19 um long 2
   Spear 21-35 um long 3
2. Body length = 0.24-0.27 mm; spear 19 um long .... bosoekianus
   Body length = 0.28-0.36 mm; spear 11-12 um long .... similis
3. Excretory pore at level of the base of basal oesophageal bulb; lip region conoid ..... pseudouncinatus
   Excretory pore at level of anterior to base of basal oesophageal bulb; lip region truncate 4
4. Spear 34-35 um long; excretory pore at level of anterior half of isthmus..... neoensus
   Spear 19-30 um long; excretory pore below the level of anterior half of isthmus 5

5. Tail digitate, acute or pointed; V = 69–83 6
   Tail conoid with rounded terminus; V = 83–85 .....
   ..... dianthus

6. Excretory pore at the level of junction of isthmus and basal bulb 7
   Excretory pore at the level of anterior half of basal bulb.
   8

7. Body length = 0.30 mm (0.27–0.34 mm); spear 22 um(19–26 um) long ..... hainiensis
   Body length = 0.35 mm (0.31–0.38 mm); spear 21 um(19–23 um) long ..... hexadus

8. Lateral fields with 3 longitudinal incisures; body length = 0.20–0.30 mm ..... minuscuius
   Lateral fields with 4 longitudinal incisures; body length = 0.33–0.40 mm 9

9. Excretory pore at the level of anterior half of basal oesophageal bulb; tail tapering gradually to a finely rounded terminus; spear 22–27 um long ..... lenidus
   Excretory pore at the level of middle of basal oesophageal bulb; tail digitate; spear 27–31 um long ..... halophilus

GENUS *GRACILACUS* RASKI, 1962

Raski (1962) placed those species of *Paratylenchus* (*sensu lato*) bearing spear more than 40 um long, excretory pore anterior to nerve ring and females plump to obese under a new genus which he named *Gracilacus*. Siddiqi & Cooley (1964) did not accept this genus and synonymised it with *Paratylenchus* (*sensu stricto*). This action of Siddiqi & Cooley was supported by Goseert (1966) and Allen & Sher (1967), but Thorne & Malek (1968) and Golden (1971) have considered it a valid genus. New species of *Gracilacus* were described by Colbran (1969), Hisra & Edward (1971), Wu (1974), Eroshenko (1974) etc. Raski (1976) provided a revision of the genus and added seven more new species. He also gave some more characters for differentiating *Gracilacus* from *Paratylenchus* and *Cacopaurus*. In the recent years, Baqri (1978) added a new species from West Bengal, Khuhro & Sanwal (1979) described another new species from Gauhati, Assam. At present, the genus includes 33 species, but only six of those are known to occur in this country. These are *G. acalli*, *G. auriculus*, *G. jamii*, *G. microletzkyi*, *G. oostenbrinki* and *G. raskii*. The diagnosis of the genus and an up-to-date list of species is given below.

Diagnosis: Paratylenchinae. Body small sized (less than 0.50 mm) slender to swollen. Body cuticle very finely striated without any ornamentations (except in *G. mutabilis*). Spear 41-119 um

in length. Secretory pore in the region of isthmus, anterior to nerve ring. Body posterior to vulva elongate. Males slender, spear absent or much reduced. Bursa absent or a slight cuticular evagination represents bursa.

Type species:

Gracilacus auxoria (Allen & Jensen, 1950) Raski, 1962

Other species:

G. abietis (Eroshenko, 1974) Raski, 1976

G. acicula (Brown, 1959) Raski, 1962

G. aculenta (Brown, 1959) Raski, 1962

G. ancora (Cobb, 1913) Raski, 1976

G. aonli (Misra & Edward, 1971) Raski, 1976

G. audriellus Brown, 1959

G. costata Raski, 1976

G. crenata (Corbett, 1966) Raski, 1976

G. elegans Raski, 1962

G. enata Raski, 1976

G. goodeyi (Goetenbrink, 1953) Raski, 1962

G. idalena Raski, 1962

G. intermedia Raski, 1962

G. inversis (Luc & De Guiran, 1962) Raski, 1976

G. jenii Negri, 1978

G. latescens Raski, 1976

G. *macrodora* (Brzeski, 1963) Raski, 1976

G. *marylandica* (Jenkins, 1960) Raski 1976

G. *micoletzkyi* (Edward, Misra & Singh, 1967) Raski, 1976

G. *mira* Raski, 1962

G. *mutabilis* (Colbran, 1969) Raski, 1976

G. *oostenbrinki* (Misra & Edward, 1971) Raski, 1976

G. *pandata* Raski, 1976

G. *paramotti* Schoemaker, 1963

G. *parvula* Raski, 1976

G. *parotica* Raski, 1962

G. *raskii* Khuman & Sanwal, 1979

G. *robusta* (Hu, 1974) Raski, 1976

G. *solivaga* Raski, 1976

G. *streeteni* (De Coninck, 1931) Raski, 1976

G. *steineri* (Golden, 1961) Raski, 1962

G. *tarsa* Raski, 1976

In the present work only a single species of this genus namely, *Crocillocus sukrialis* Brown, 1959 was recorded from the hills of Mussoorie, Dehradun. It represents the first record of this species from India.

GRACILACUS AUDRIELLUS BROWN, 1959
(Fig. 49)

Dimensions:

Female: L = 0.32 mm; a = 25; b = 2.9; c = 10; V = 77; VL/VB = 7; spear 59 um; metenchium = 47 um; excretory pore = 87 um.

Habitat and locality: Soil around roots of peach, *Prunus persica* from Company Gardens, Mussorrie, Dehradun, Uttar Pradesh.

Remarks: *Gracilacus audriellus* was described by Brown (1959) from Canada. Coraort (1965) reported it from Belgium. The single female conforms well with those redescribed by Raski(1976).

KEY TO INDIAN SPECIES OF *GRACILACUS*

1. Spear more than 72 um long ..... *contenbrinki*
   Spear 41–65 um long 2
2. Lateral fields with 2 incisures ..... *jamii*
   Lateral fields with 4 incisures 3
3. Vulval flap present 4
   Vulval flap absent 5

4. Body length = 0.25–0.31 mm ..... **acuti**

   Body length = 0.37–0.44 mm ..... **subtriolium**

5. Spear 41–46 um long; V = 82–84 ..... **nicolotskyi**

   Spear 58–62 um long; V = 70–73 ..... **rauskii**

SUMMARY

In the present work 55 species of nematodes belonging to the suborder Criconematina of the order Tylenchida have been described from specimens collected in India and Nepal. Fifteen genera under three superfamilies, four families and six subfamilies have been discussed and 36 known and 19 new species have been described. Of the 36 known species, 12 species are being recorded for the first time from India. An outline classification of Criconematina along with the diagnoses of different familial groups and genera has been provided. Identification keys to familial groups and genera of Criconematina and to Indian species of all the genera discussed in this work have also been given.

I. The suborder:

Criconematina Siddiqi, 1980

II. The superfamilies:

1. Criconematoidea Taylor, 1936 (Geraert, 1966)
2. Hemicycliophoroidea Skarbilovich, 1959 (Siddiqi, 1980)
3. Tylenchuloidea Skarbilovich, 1947 (Raski & Siddiqui, 1975)

III. The families:

1. Criconematidae Taylor, 1936 (Thorne, 1949)
2. Hemicycliophoridae Skarbilovich, 1959 (Geraert, 1966)

3. Calcoelidae Siddiqi, 1980

4. Paratylenchidae Thorne, 1949 (Raski, 1962).

IV. The subfamilies:

1. Criconematinae Taylor, 1936

2. Necropsothoniinae Skarbilovich, 1959

3. Hemicriconemoidinae Andrássy, 1979

4. Hemicycliophorinae Skarbilovich, 1959

5. Caloosiinae Siddiqi, 1980

6. Paratylenchinae Thorne, 1949

V. The genera

1. Crossonema Mehta & Raski, 1971

2. Neolobocriconema Mehta & Raski, 1971

3. Lobocriconema De Grisse & Loof, 1965

4. Gracilacus Southern, 1914

5. Leptocriconemella Mehta & Raski, 1971 (Khan, Chawla & Saha, 1976)

6. Necropsothonia De Man, 1880

7. Criconemella De Grisse & Loof, 1965

8. Discocriconemella De Grisse & Loof, 1965

9. Xenocriconemella De Grisse & Loof, 1965

10. Hemicriconemoides Chitwood & Birchfield, 1957

11. Hemicycliophora De Man, 1921

12. Antarctenchus Siddiqi, 1980

13. Caloosia Siddiqi & Cooley, 1964

14. Geratylenchus Nicolotzky, 1922

15. Gracilacus Raski, 1962

VI. The known species:

1. Crossonema euryaema Golden & Friedman, 1964

2. Crossonema fimbriatum (Cobb in Taylor, 1936)
Mehta & Raski, 1971

3. Crossonema fimcivatum Khan, Chawla & Saha, 1976

4. Crossonema multiscumatum (Kirjanova, 1948)
Mehta & Raski, 1971

5. Neolobocriconema eberrana (Jairajpuri & Siddiqi, 1963)
Andrássy, 1979

6. Nothocriconema acriculum Raski & Pinochet, 1976

7. Nothocriconema corbetti De Grisse, 1967

8. Nothocriconema jaajuense Choi & Geraert, 1975

9. Nothocriconema kovacsi (Andrássy, 1963)
De Grisse & Loof, 1967

10. Nothocriconema mukevum Khan, Chawla & Saha, 1976

11. Uema coffeae (Edward, Misra & Rai, 1970) Andrássy, 1979

12. Uema octangulare (Cobb, 1914) Sch. Stekhoven & Teunissen, 1938

13. Seriespinula imrae Khan, Chawla & Saha, 1976

14. Seriespinula tenuicaudata (Siddiqi, 1961)
Khan, Chawla & Saha, 1976

15. Macroposthonia basili (Jairajpuri, 1964)
De Grisse & Loof, 1965

16. Macroposthonia complexa (Jairajpuri, 1963)
De Grisse & Loof, 1965

17. Macroposthonia obtusicaudatum (Heyns,1962) Heyns,1970

18. Macroposthonia onoensa (Luc, 1959) De Grisse & Loof, 1965

19. Macroposthonia onoetria Chukan & Sanwal, 1980

20. Macroposthonia xuni (Siddiqi, 1961) De Grisse & Loof, 1965

21. Macroposthonia rusium Khan, Chawla & Saha, 1976

22. Macroposthonia rustica (Micoletzky, 1915) De Grisse & Loof, 1965

23. Macroposthonia archaeocephala (Taylor, 1936) De Grisse & Loof, 1965

24. Lenocriconemella macrodora (Taylor, 1936) De Grisse & Loof, 1965

25. Hemicriconemoides cocophillus (Loos, 1949) Chitwood & Birchfield, 1957

26. Hemicriconemoides mangiferae Siddiqi, 1961

27. Hemicycliophora dhirendri Husain & Khan, 1967

28. Aulacohora costenbrinki (Luc, 1958) Siddiqi, 1980

29. Aulacohora penetrans (Thorne, 1955) Siddiqi, 1980

30. Coloosia indica Chawla & Sanathanam, 1980

31. Coloosia paralongicaudata Siddiqi & Goodey, 1964

32. Paratylenchus basoekianus Micoletzky, 1922

33. Paratylenchus halenhilus Nouts, 1966

34. Paratylenchus minusculus Tarjan, 1960

35. Paratylenchus naimianus Edward & Misra, 1963

36. Gracilacus audriellus Brown, 1959.

VII. The new species:

1. Criconema raskii
2. Neoloboriconema brevistylum
3. Neoloboriconema neoberrans
4. Hoplocriconema corbulatum
5. Hoplocriconema chamolii
6. Hoplocriconema himalicum
7. Ogma paraectenulare
8. Ogma parvum
9. Ogma unum
10. Macroposthonia paraexcata
11. Macroposthonia kalinei
12. Macroposthonia mandelensis
13. Criconemella andrassyi
14. Discocriconemella aquatica
15. Hemicriconemoides serratus
16. Hemicriconemoides indicus
17. Hemicriconemoides caudatus
18. Hemicycliophora conari
19. Hemicycliophora parasubclica

VIII. First records from India

1. Criconema fimbriatum (Cobb in Taylor, 1936) Mehta & Raski, 1971
2. Criconema multiaquenatum (Kirjanova, 1948) Mehta & Raski, 1971

3. Hothocricenema acriculum Raski & Pinochet, 1976
4. Hothocricenema corbetti De Grisse, 1967
5. Hothocricenema jaejuense Choi & Geraert, 1975
6. Macroposthonia obtusicaudatum (Heyns, 1962) Heyns, 1970
7. Macroposthonia rustica (Micoletzky, 1915) De Grisse & Loof, 1965
8. Auleorhora costenbrinki (Luc, 1958) Siddiqi, 1980
9. Auleorhora penetrans (Thorne, 1955) Siddiqi, 1980
10. Paratylenchus halophilus Wouts, 1966
11. Paratylenchus minusculus Terjan, 1960
12. Cricilacus auriculius Brown, 1959

IX. The new combination:

Auleorhora utkali (Ray & Das, 1980) n. comb.

X. The synonyms

1. Calocaris Zakaryai Phukan & Sanwal, 1979 of
C. longicaudata (Loos, 1948) Siddiqi & Goodey, 1964

2. Hemicycliophora damani Edward & Rai, 1970 of
H. dhirendri Husain & Khan, 1967

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Fig. 1

A - D [illegible]

A - Entire female.

B - Oesophageal region.

C - Surface of annules on midbody.

D - Posterior end.

E - G, [illegible]

E - Oesophageal region.

F - Surface of annules on midbody.

G - Posterior end.

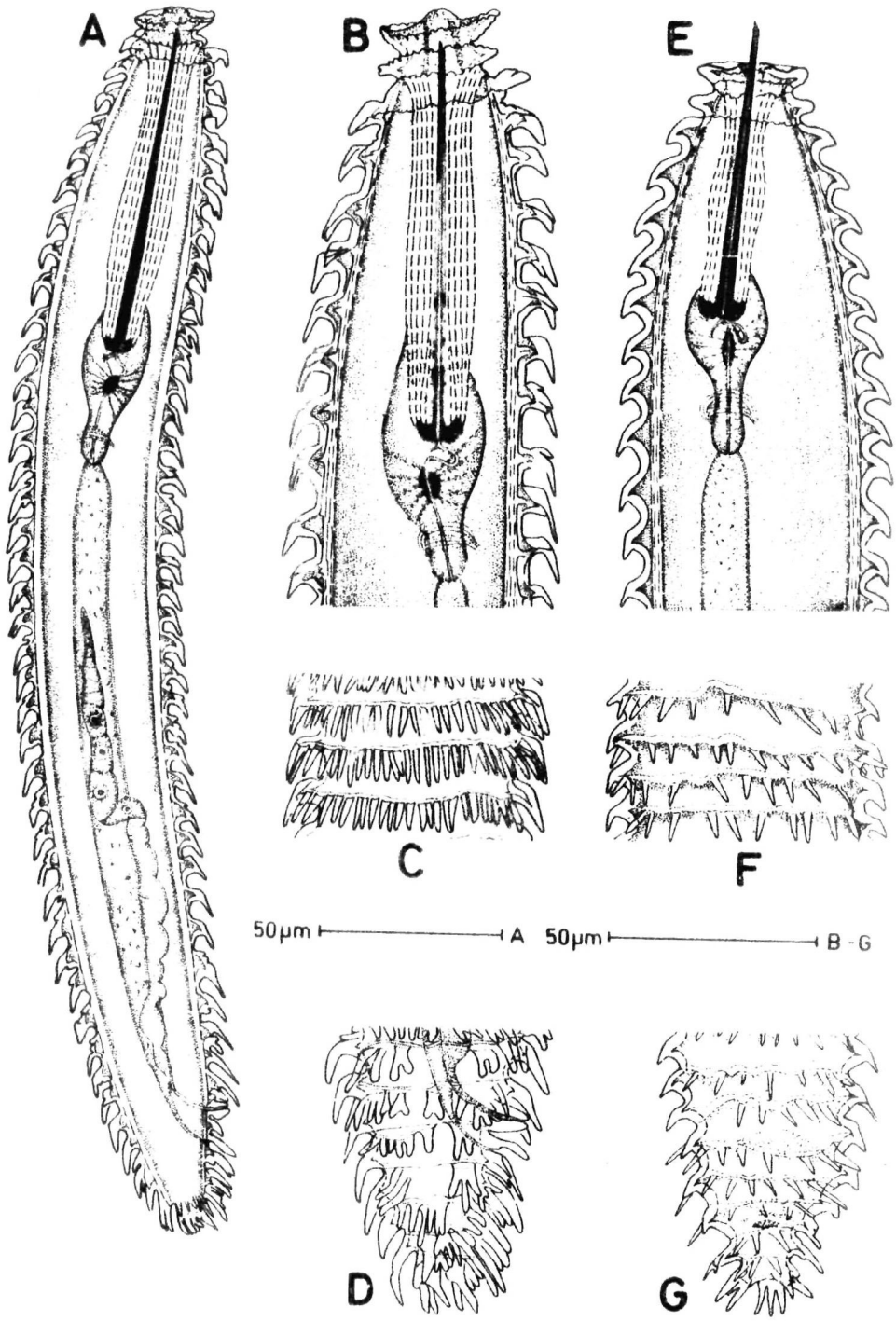

A
B
E
C
F
50µm
A
50µm
B - G
D
G

Fig. 2

CRICONEMA FIMBRIATUM

A - Entire female.

B - Anterior end.

C - Oesophageal region.

D - Cross-section through midbody.

E - Surface of annules on midbody.

F - Posterior end.

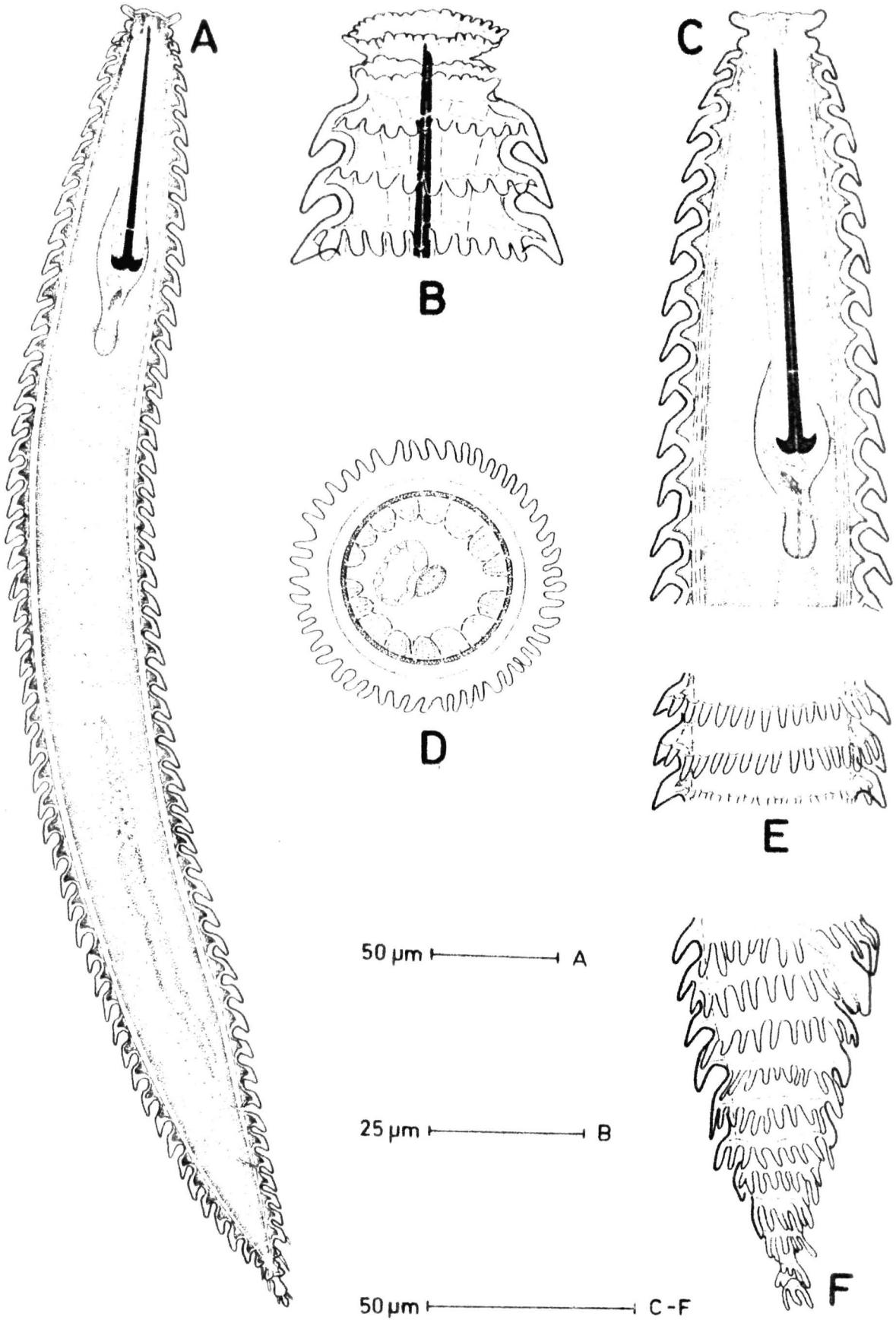

A
B
C
D
E
F
50 µm
A
25 µm
B
50 µm
C - F

Fig. 3

CHROMATIUM EUCLIVATUM

A - Entire female.

B - Oesophageal region.

C - Anterior end.

D - En face view.

E - Cross-section through midbody.

F - Surface of annules on midbody.

G - Posterior end.

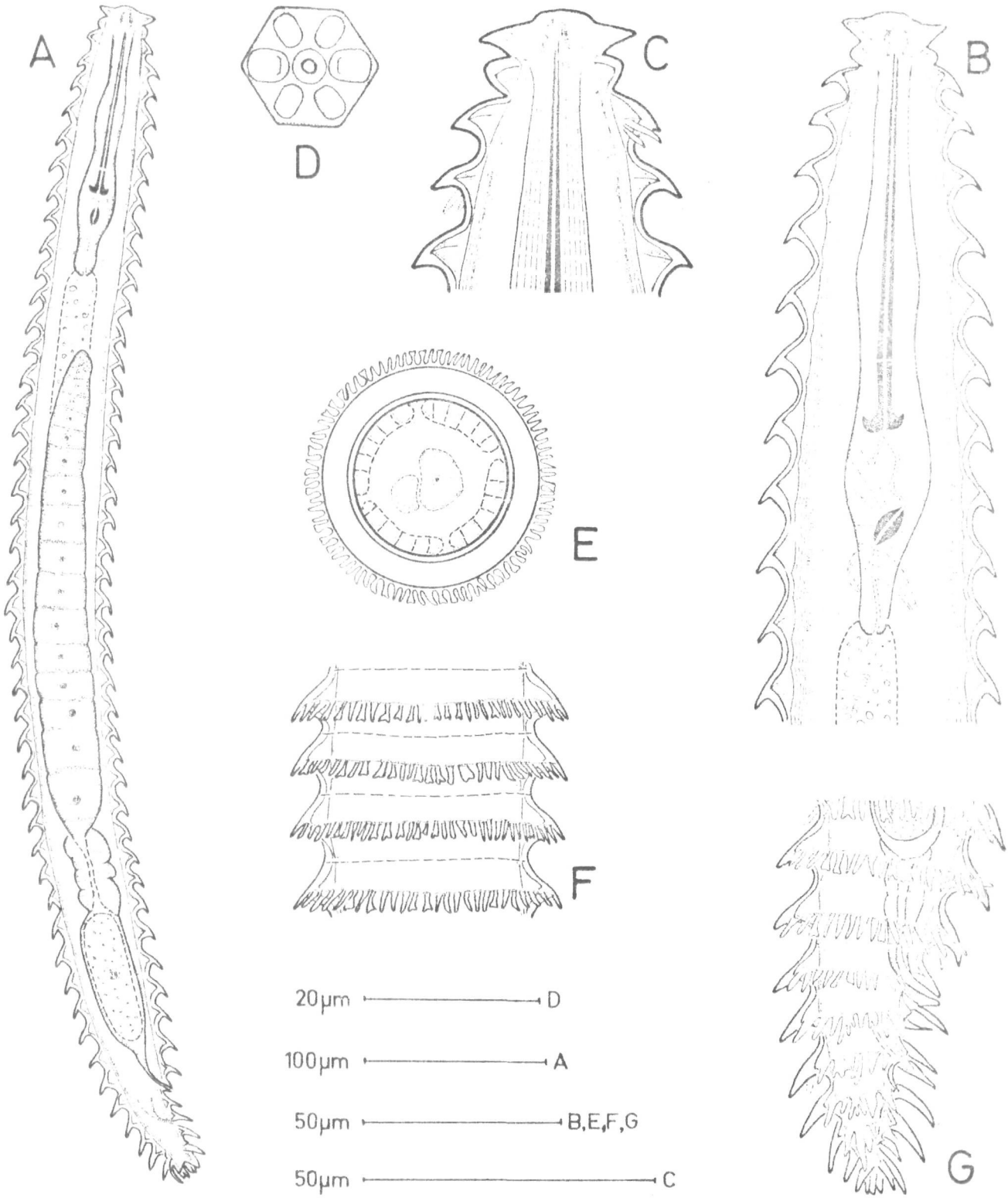

A
D
C
B
E
F
G
20µm
D
100µm
A
50µm
B,E,F,G
50µm
C

Fig. 4

[redacted]
(Juvenile)

A - Entire female,

B - Oesophageal region,

C - Anterior end,

D - En face view

E - Posterior end,

F - Cross-section through midbody.

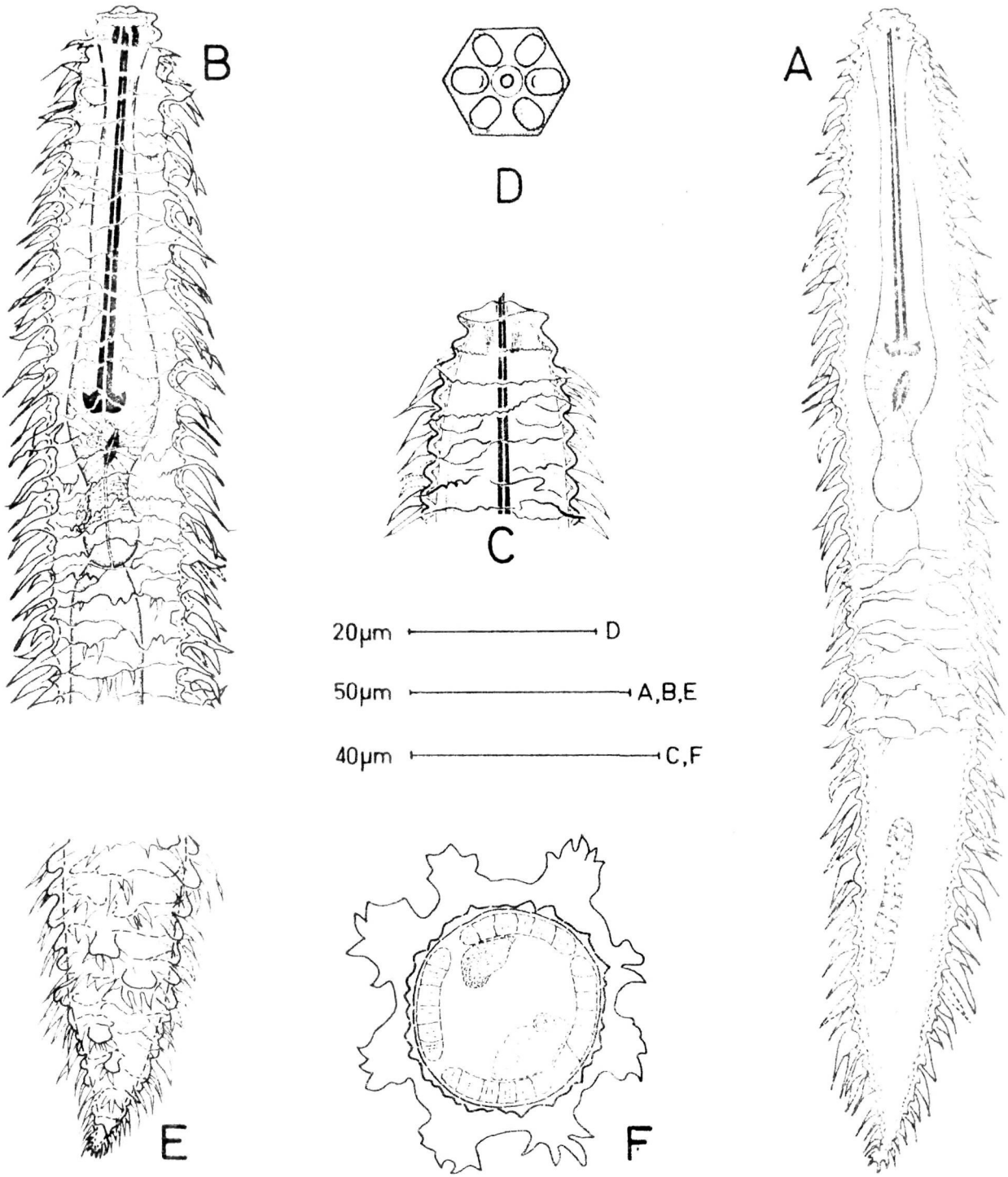

A
B
C
D
E
F
20µm
D
50µm
A,B,E
40µm
C,F

Fig. 5

[illegible] BOSKII N. SP.

A - Entire female.

B - En face view.

C - Anterior end.

D - Oesophageal region.

E - Cross-section through midbody.

F - Surface of annules on midbody.

G - Posterior end.

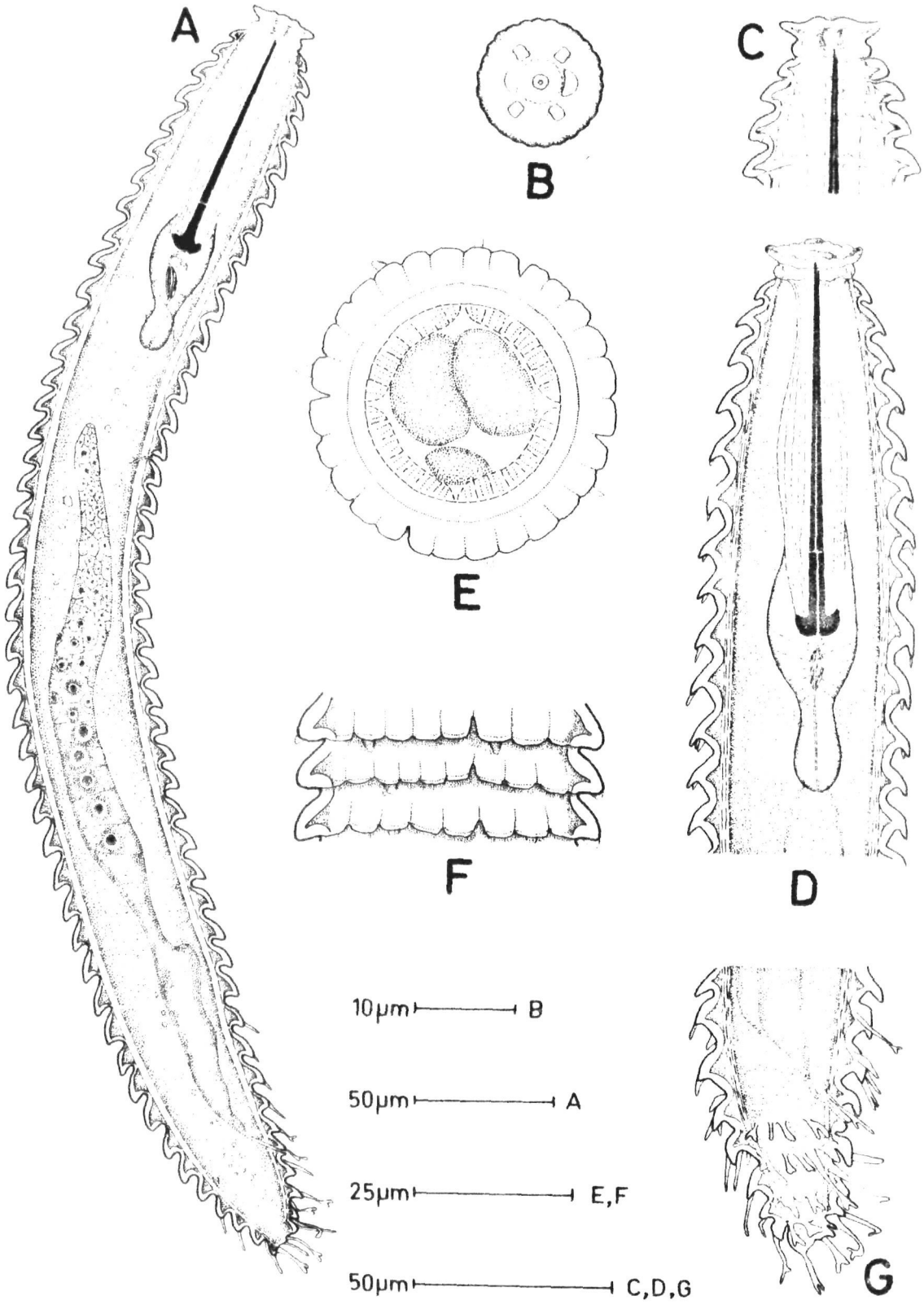

A
B
C
E
F
D
G
10µm
B
50µm
A
25µm
E,F
50µm
C,D,G

Fig. 6

[illegible]

A - Entire female,

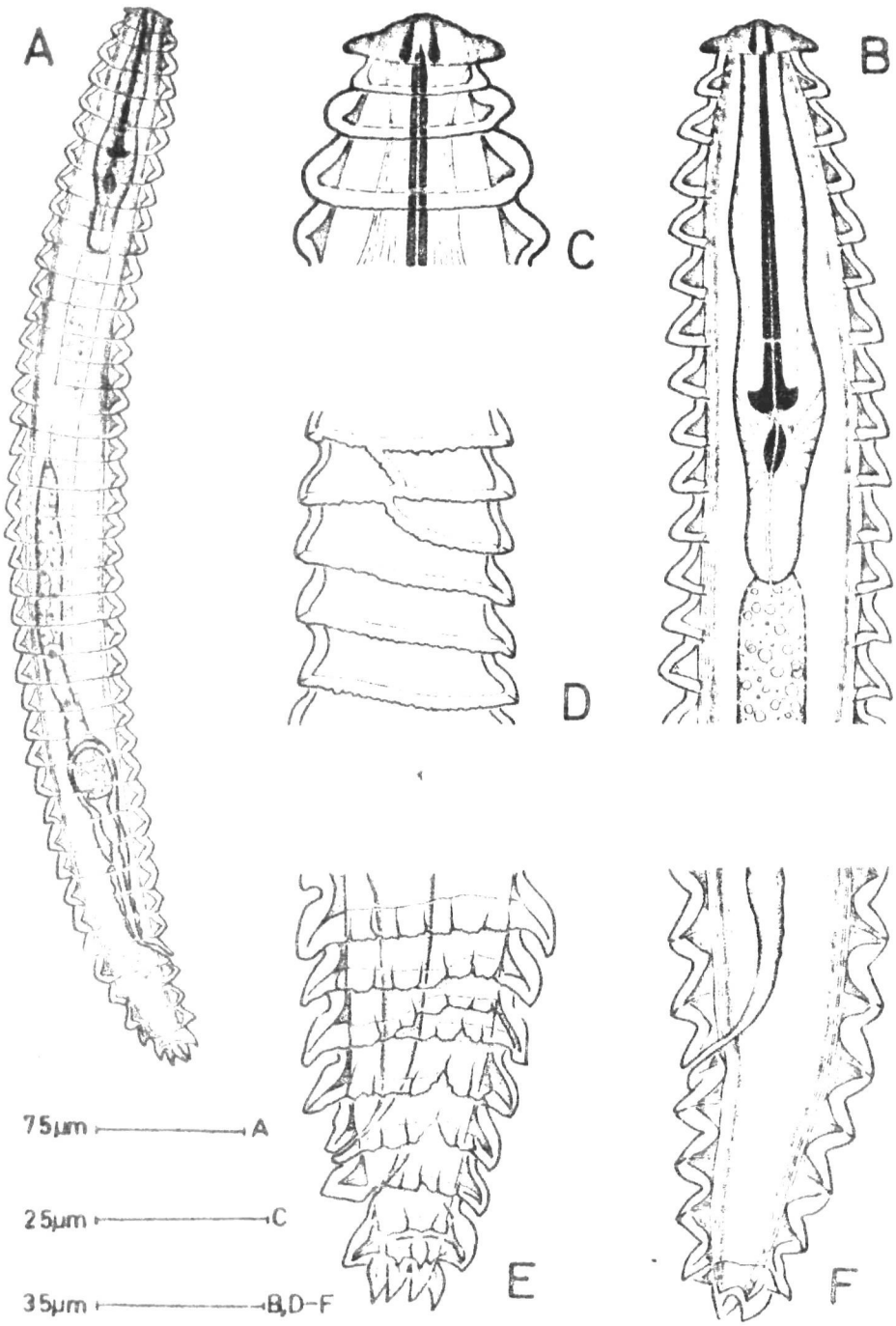
B - Oesophageal region,

C - Anterior end,

D - Surface of annules on midbody,

E - Posterior end (dorsoventral),

F - Posterior end (lateral).


A
B
C
D
E
F
75µm
A
25µm
C
35µm
B,D–F

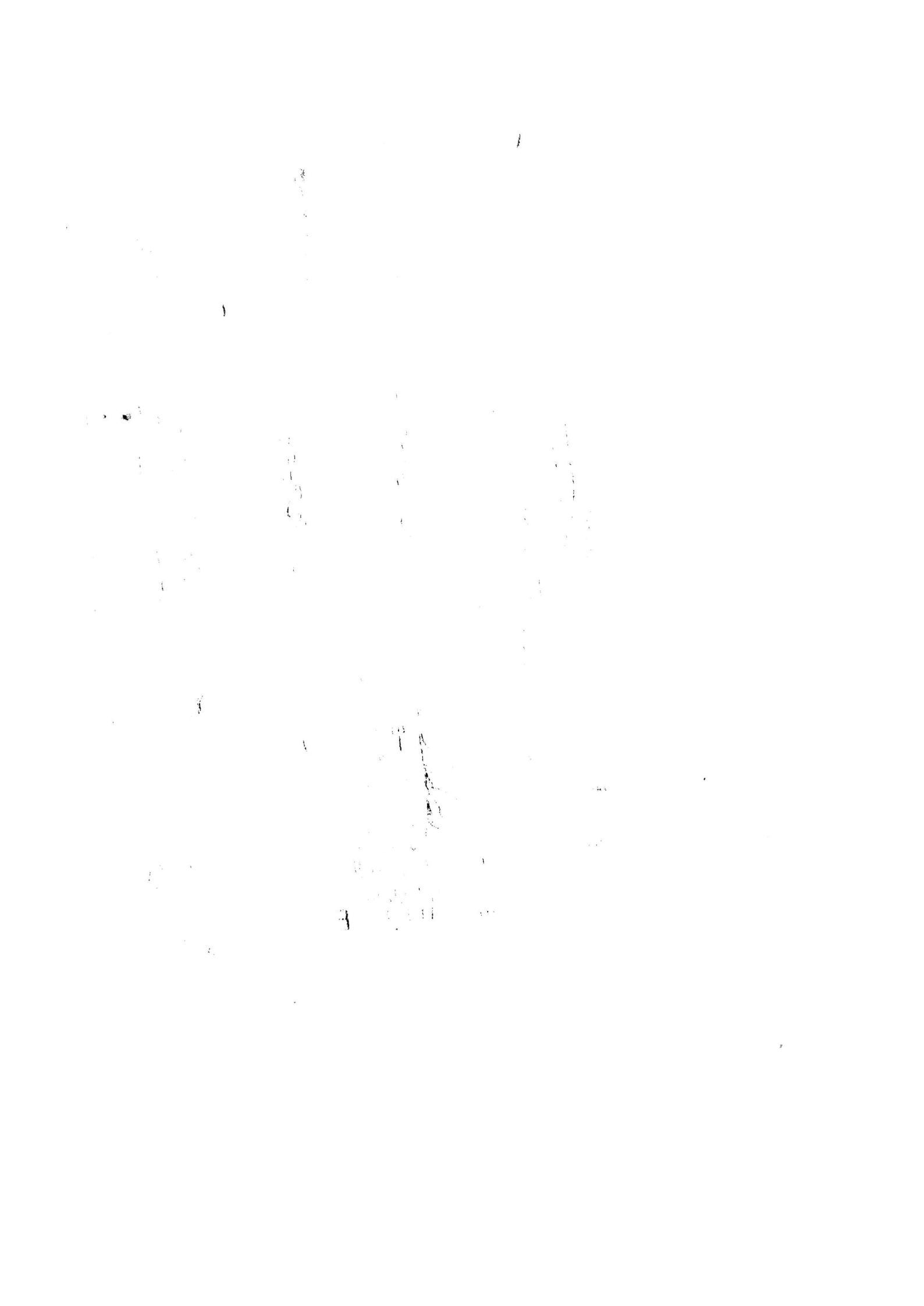


Fig. 7

[illegible] N. sp.

A - Entire female,

B - En face view

C - Oesophageal region,

D - Cross-section through midbody,

E - Surface of annules on midbody,

F - Posterior end.

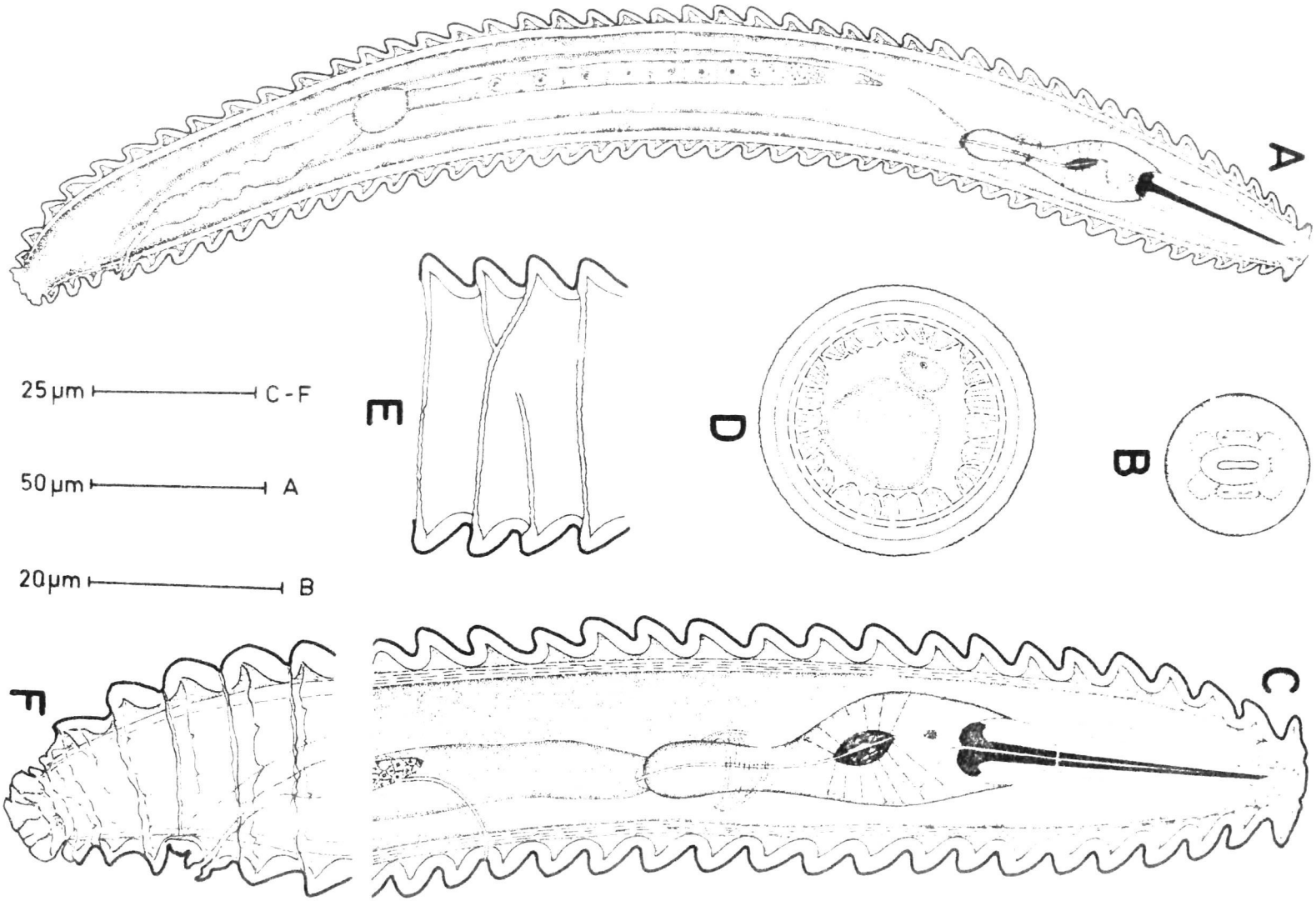

A
B
C
D
E
F
25 µm
C - F
50 µm
A
20 µm
B

Fig. 8

[illegible] N. sp.

A - Entire female.

B - Anterior end.

C - Oesophageal region.

D - Surface view showing excretory pore.

E - Surface of annules on midbody

F - Posterior (dorsoventral).

G - Posterior end (lateral).

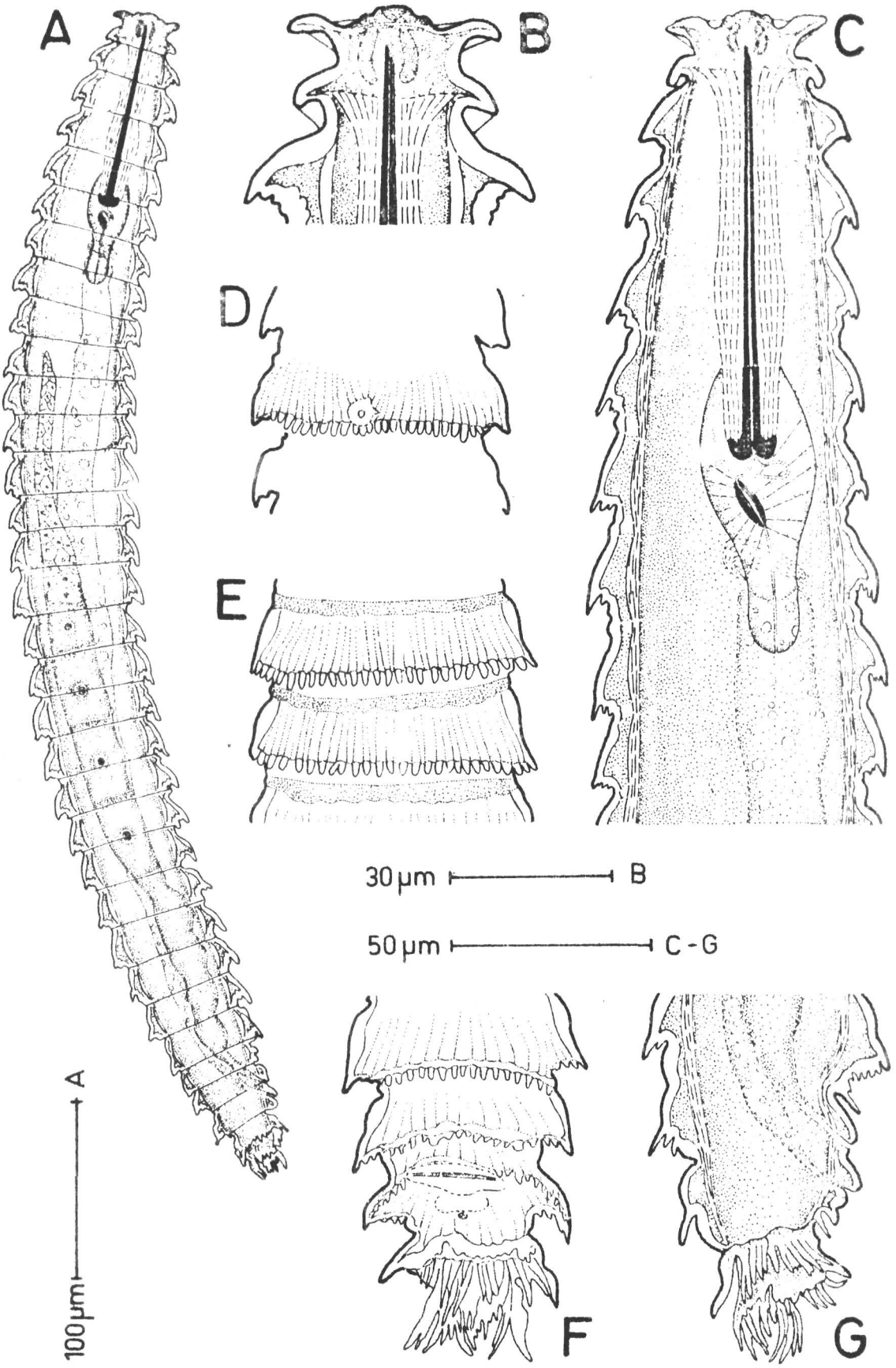

A
B
C
D
E
30 µm
B
50 µm
C - G
A
100 µm
F
G

Fig. 9

A - C, [illegible]

A - Oesophageal region,

B - Surface of annules on midbody,

C - Posterior end.

D - F, [illegible]

D - Oesophageal region,

E - Surface of annules on midbody,

F - Posterior end.

G - I, [illegible]

G - Oesophageal region,

H - Surface of annules on midbody,

I - Posterior end.

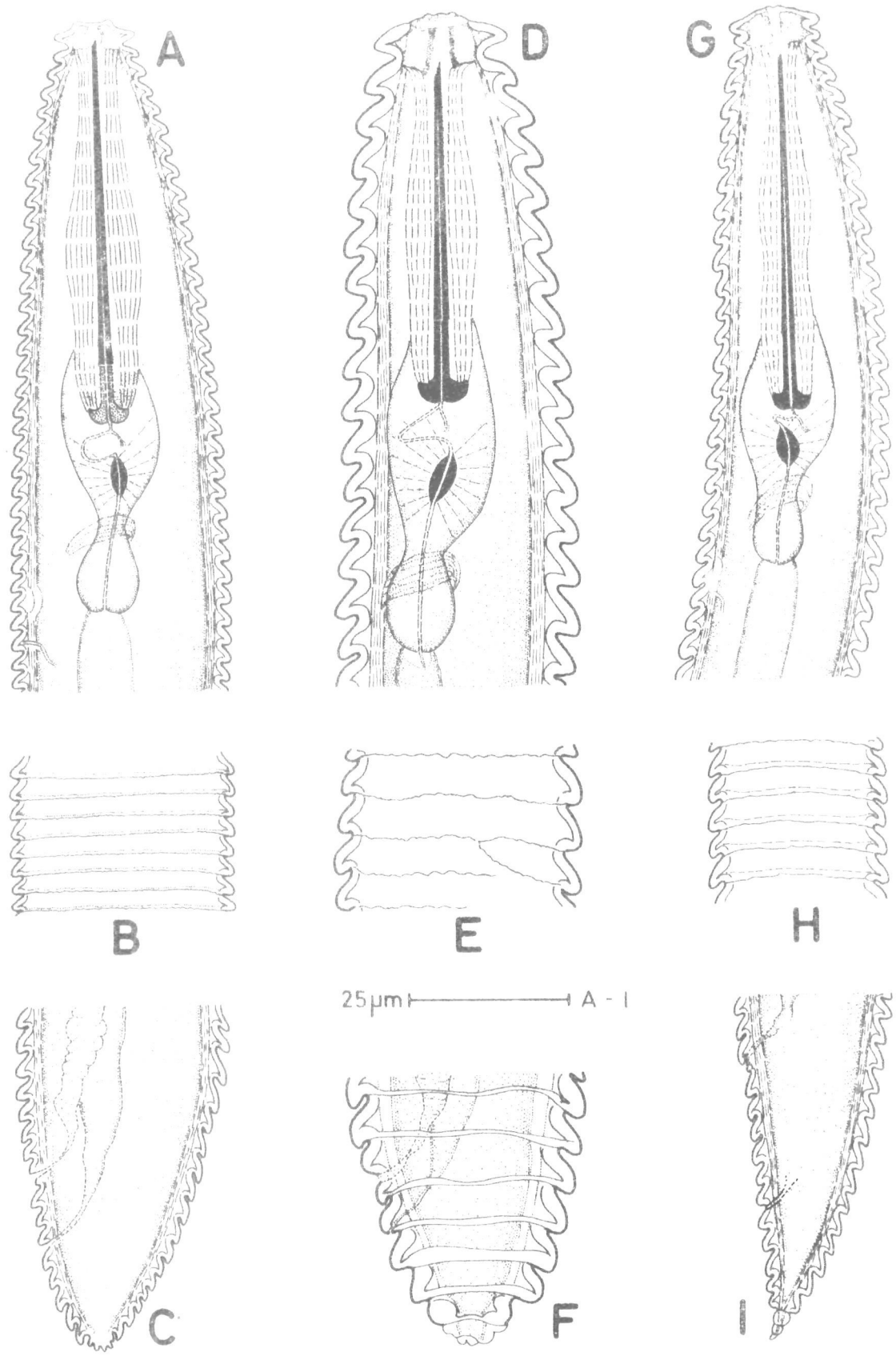

A
D
G
B
E
H
25µm
A - 1
C
F
I

Fig. 10

A - E, [illegible]

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Surface of annules on midbody,

E - Posterior end.

F - J, [illegible]

F - Entire female,

G - Anterior end,

H - Oesophageal region,

I - Surface of annules on midbody,

J - Posterior end.

C
B
G
H
A
F
50 µm
A,F
D
I
E
10 µm
B-G
25 µm
C-E
25 µm
H-J
J

Fig. 11

MACROCYCLUS CORNUATUS n. sp.

A - Entire female.

B - Anterior end.

C - Oesophageal region.

D & E- Surface of annules on midbody.

F - Posterior end.

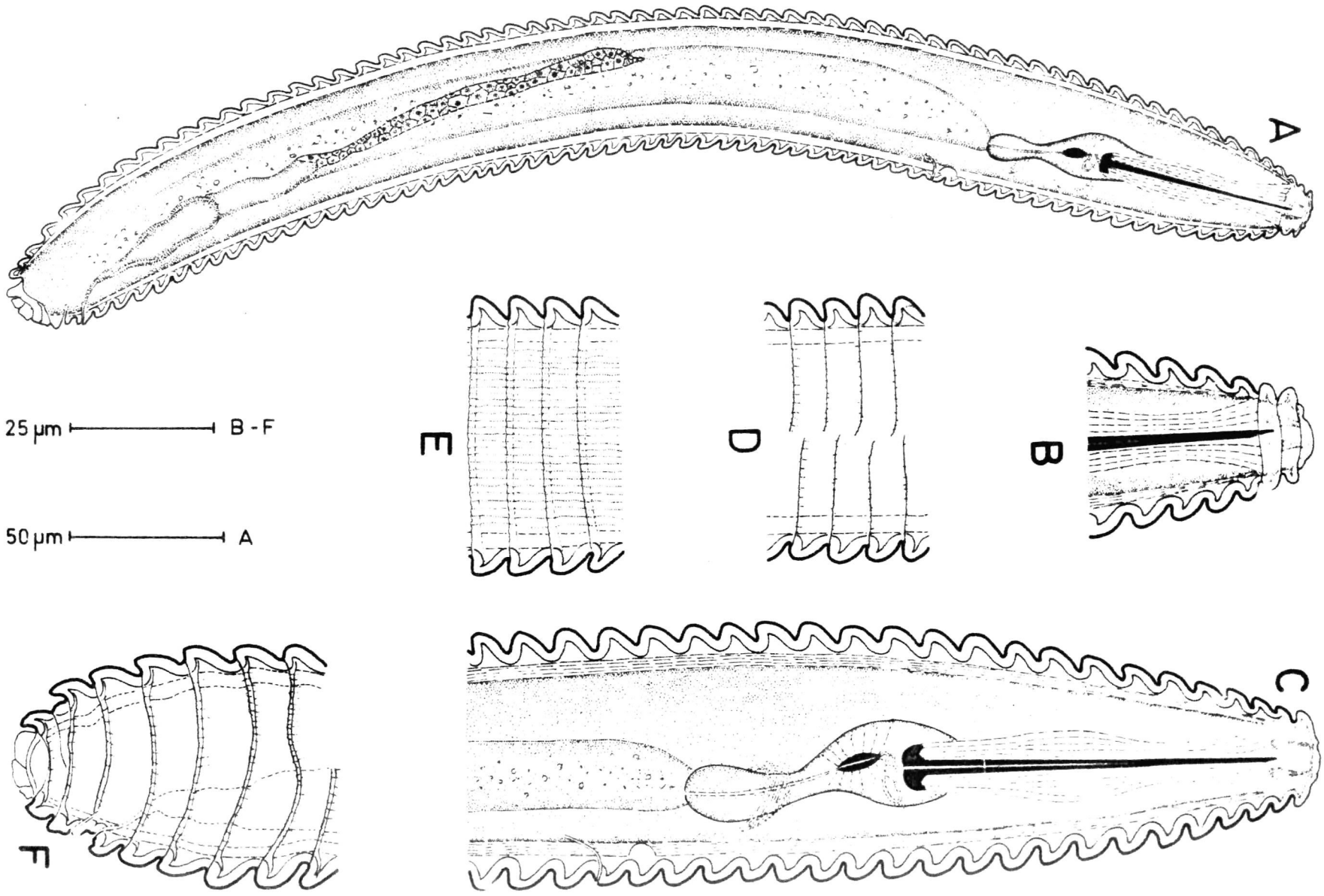

A
25 µm
B - F
50 µm
A
E
D
B
F
C

Fig. 12

[illegible] B. 5?.

A - Entire female.

B - Anterior end.

C - Oesophageal region.

D - Cross-section through midbody.

E - Surface of annules on midbody.

F - Posterior end.

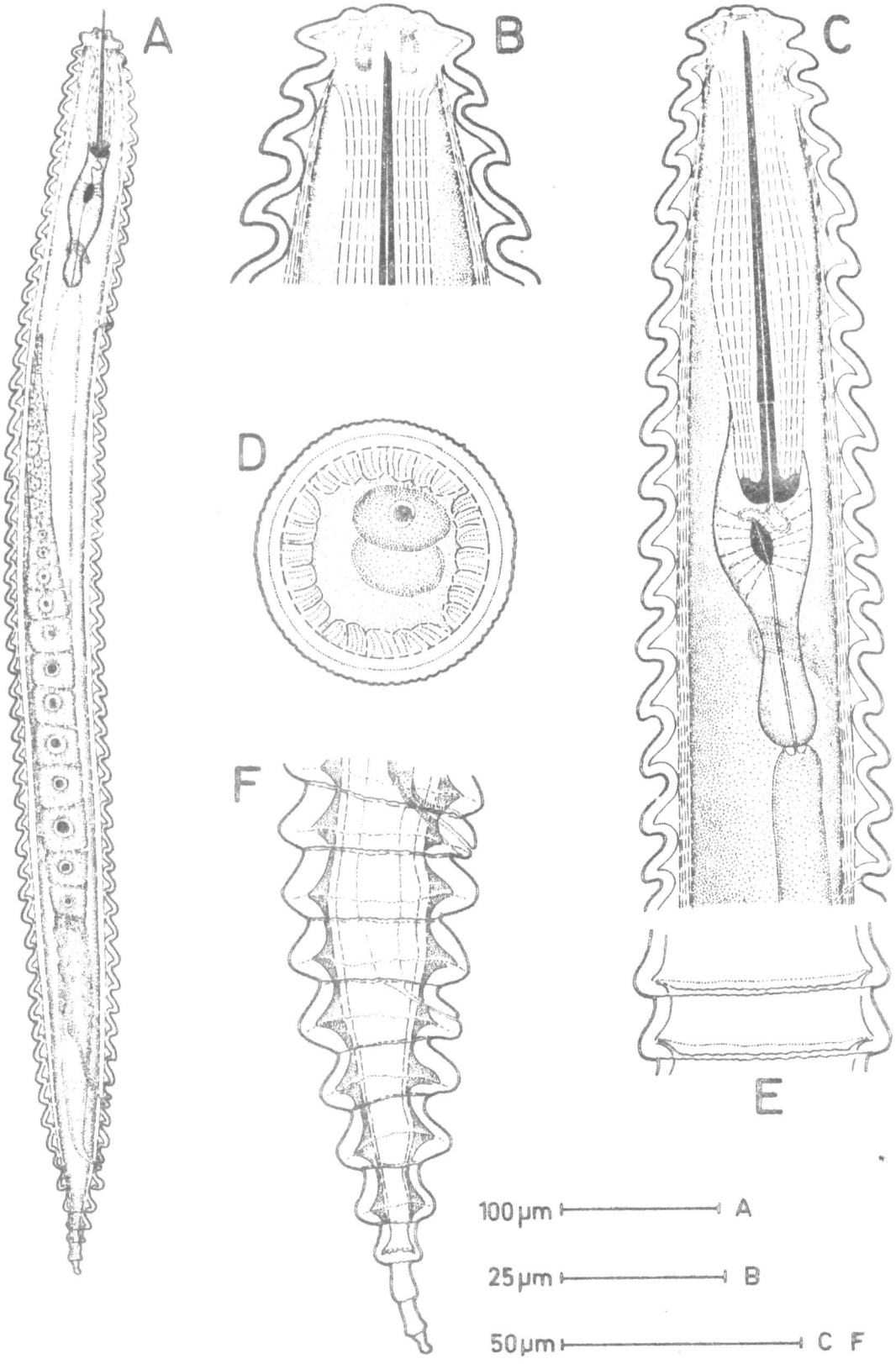

A
B
C
D
E
F
100 µm
A
25 µm
B
50 µm
C F

Fig. 13

[illegible] [illegible] N. sp.

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D, E & F- Surfaces of annules on midbody,

G - Posterior end.

A
B
C
D
E
F
G
15 µm
B
25 µm
C-G
50 µm
A

Fig. 14

[illegible]

A = Entire female.

B = Anterior end.

C = Oesophageal region.

D = Surface of annules on midbody.

E = Cross-section through midbody.

F = Posterior end.

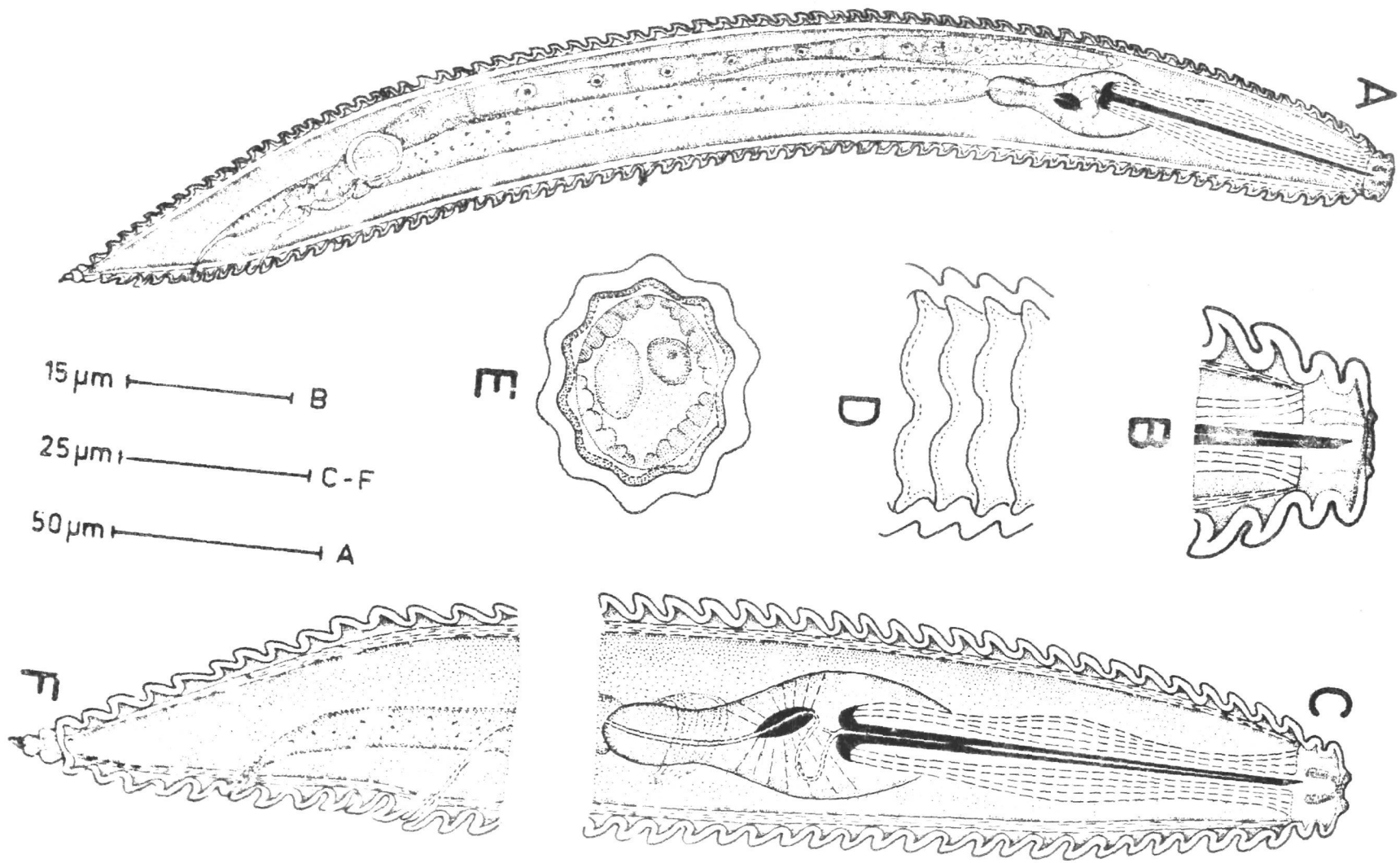

A
B
C
D
E
F
15 µm
25 µm
50 µm
B
C-F
A

Fig. 15

[illegible]

A - Entire female,

B - Oesophageal region,

C - Anterior end,

D - Cross-section through midbody,

E - Surface of annules on midbody,

G - Posterior end.

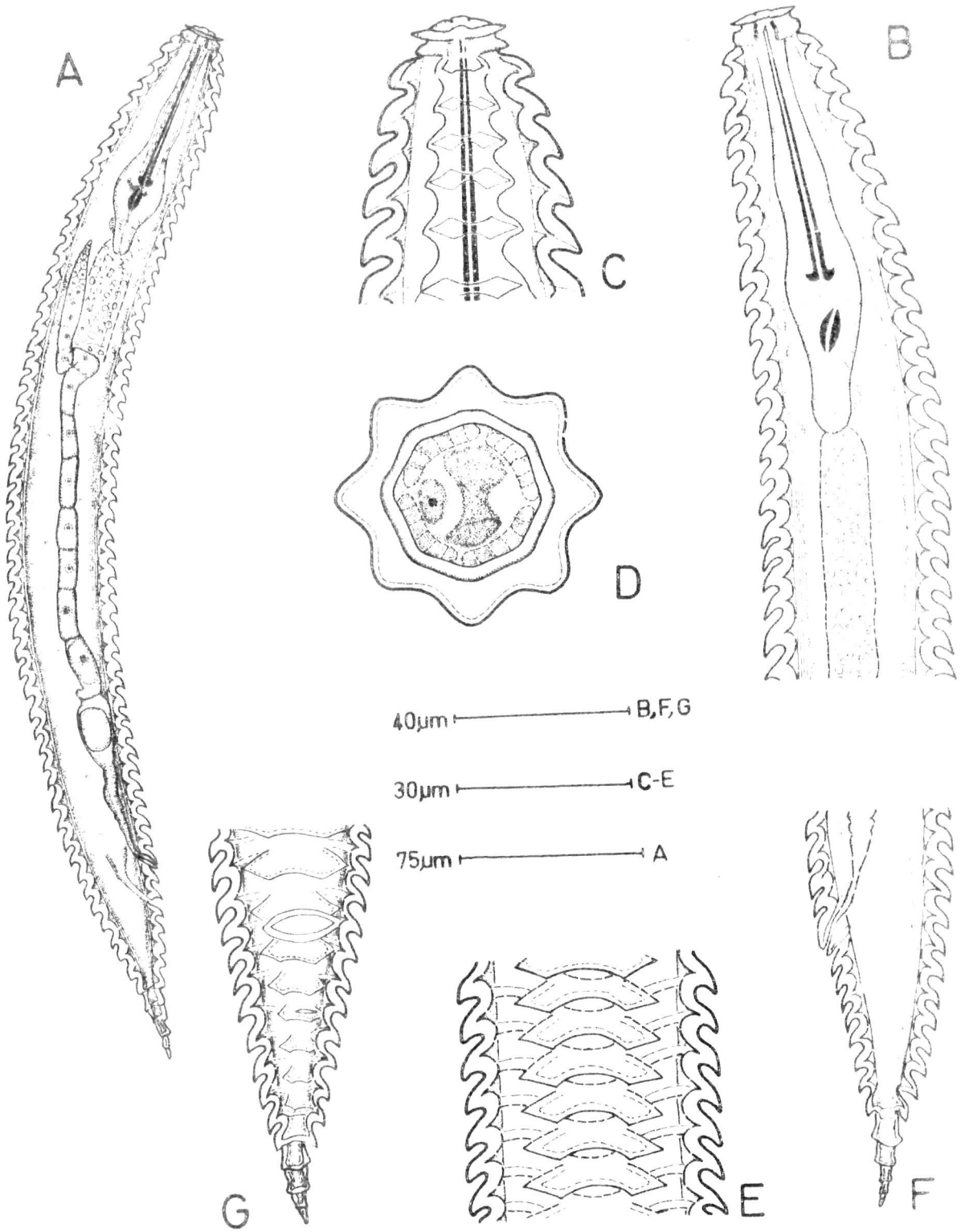

A
B
C
D
40µm
B,F,G
30µm
C-E
75µm
A
G
E
F

Fig. 16

[illegible] n. sp.

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Cross-section through midbody,

E - Surface of annules on midbody,

F - Posterior end.

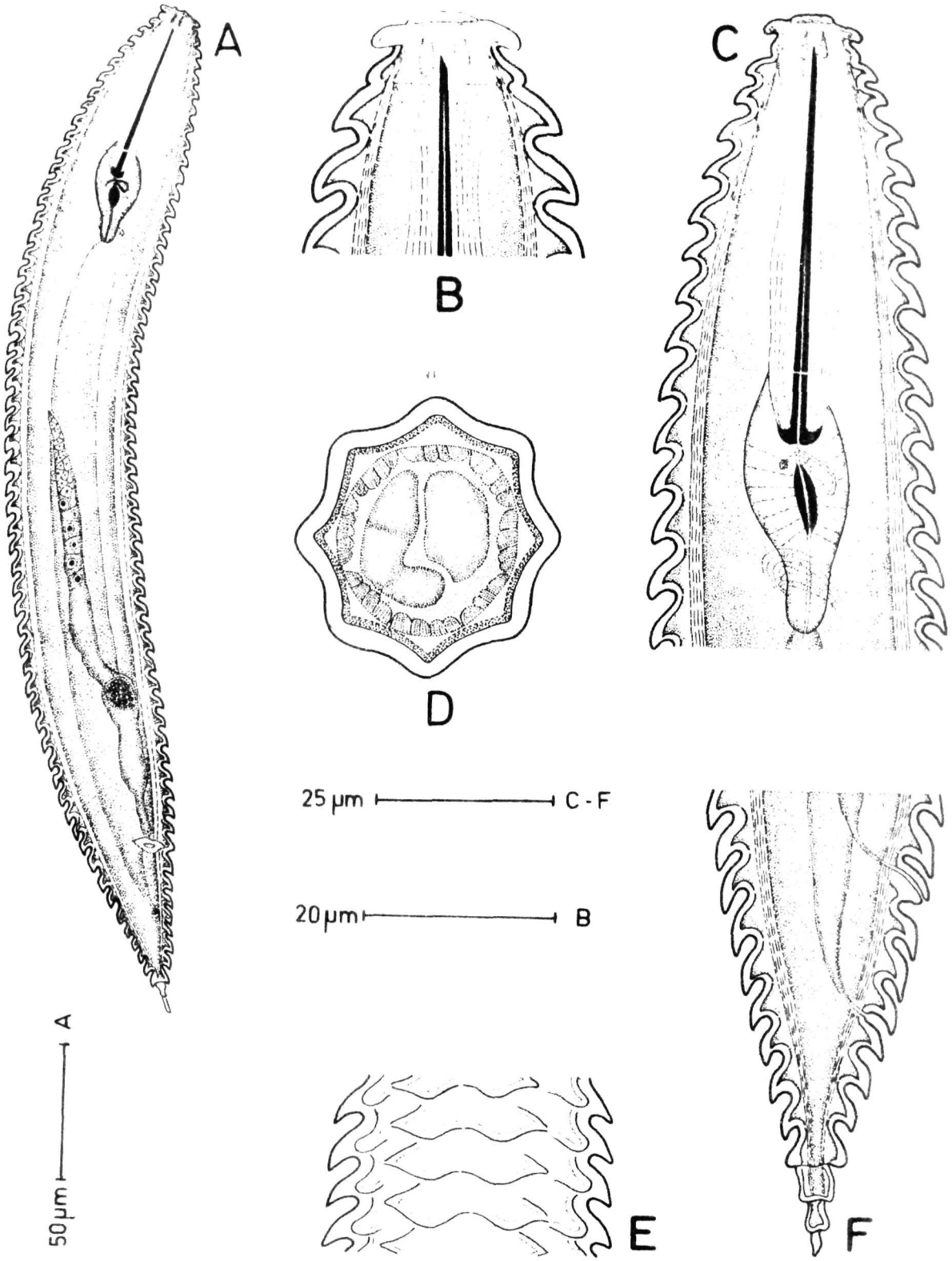

A
B
C
D
25 µm
C - F
20 µm
B
A
50 µm
E
F

Fig. 17

Genus [illegible] n. sp.

A - Entire female.

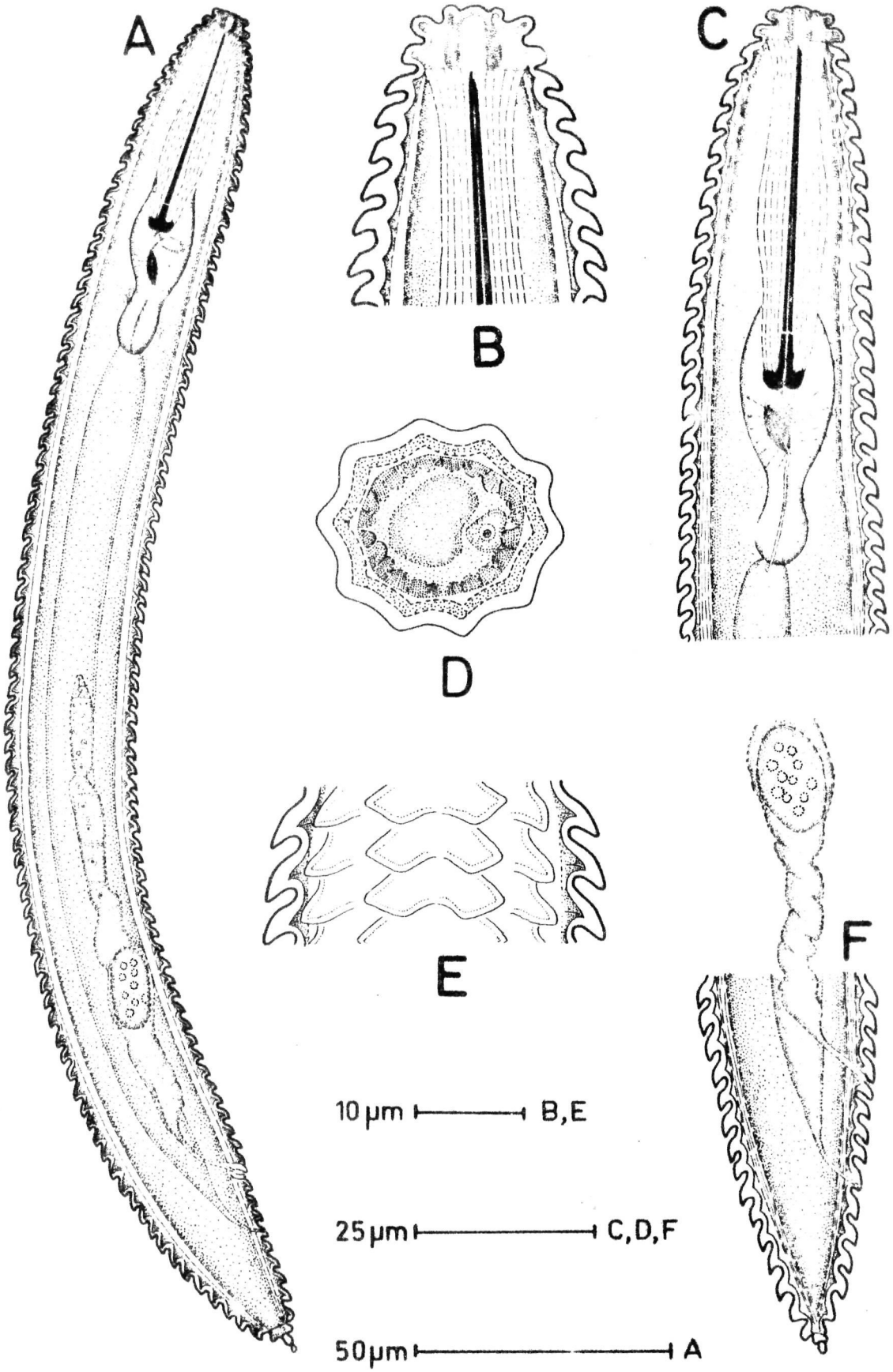
B - Anterior end.

C - Oesophageal region.

D - Cross-section through midbody.

E - Surface of annules on midbody.

F - Posterior end, showing spermatheca.


A
B
C
D
E
F
10 µm
B,E
25 µm
C,D,F
50 µm
A

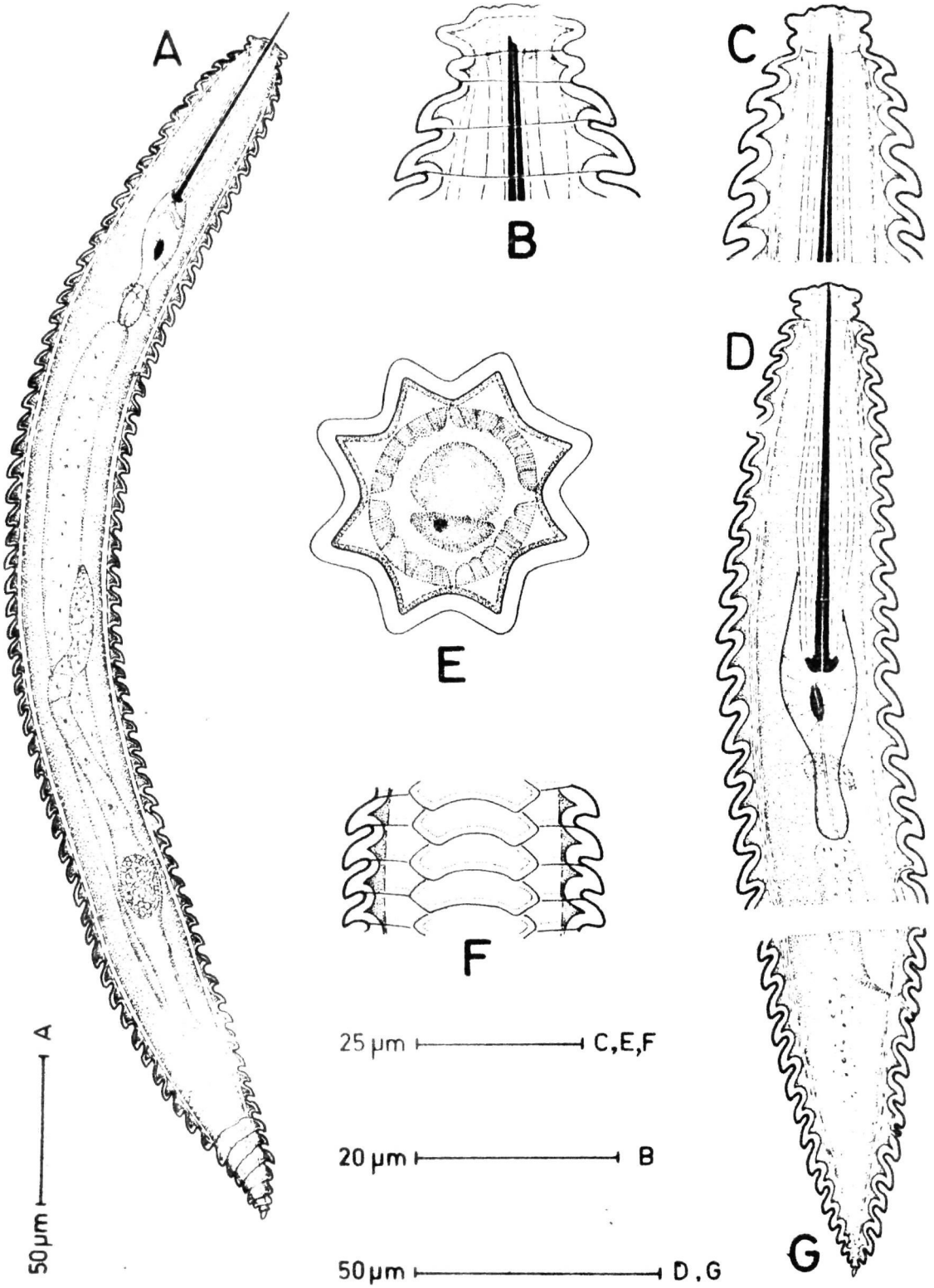

A
B
C
D
E
F
G
50µm
A
25 µm
C,E,F
20 µm
B
50µm
D,G

Fig. 19

SPRINGHILLS H.248

A - Entire female.

B - Oesophageal region.

C - Cross-section through midbody.

D - Surface of annules on midbody.

E - Posterior end (dorsoventral)

F - Posterior end (lateral).

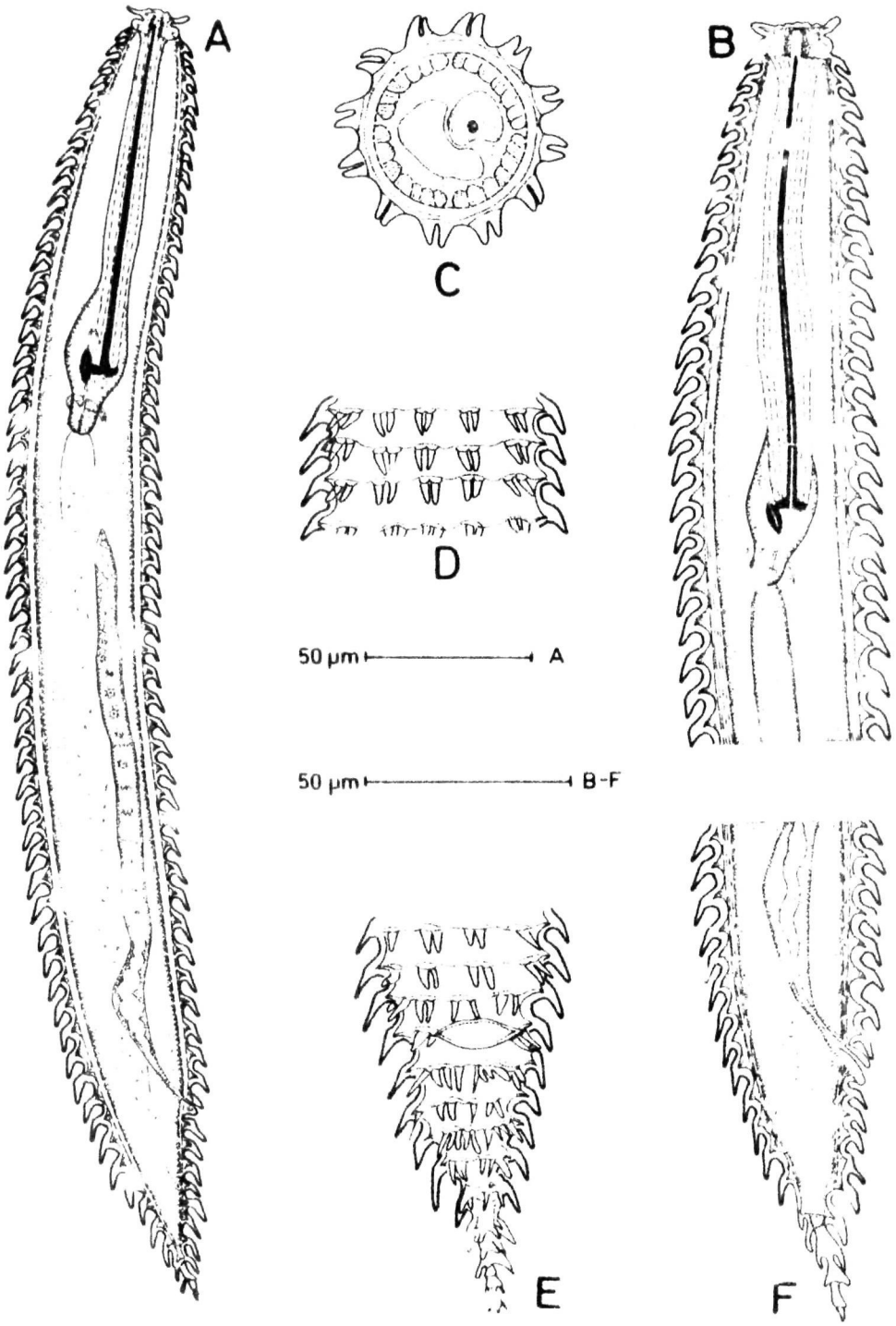

A
C
B
D
50 µm
A
50 µm
B-F
E
F

Fig. 20

[illegible]

A - Entire female,

B - Oesophageal region,

C - Surface of annules on midbody,

D - Cross-section through midbody,

E - Posterior end (dorsoventral),

F - Posterior end (lateral).

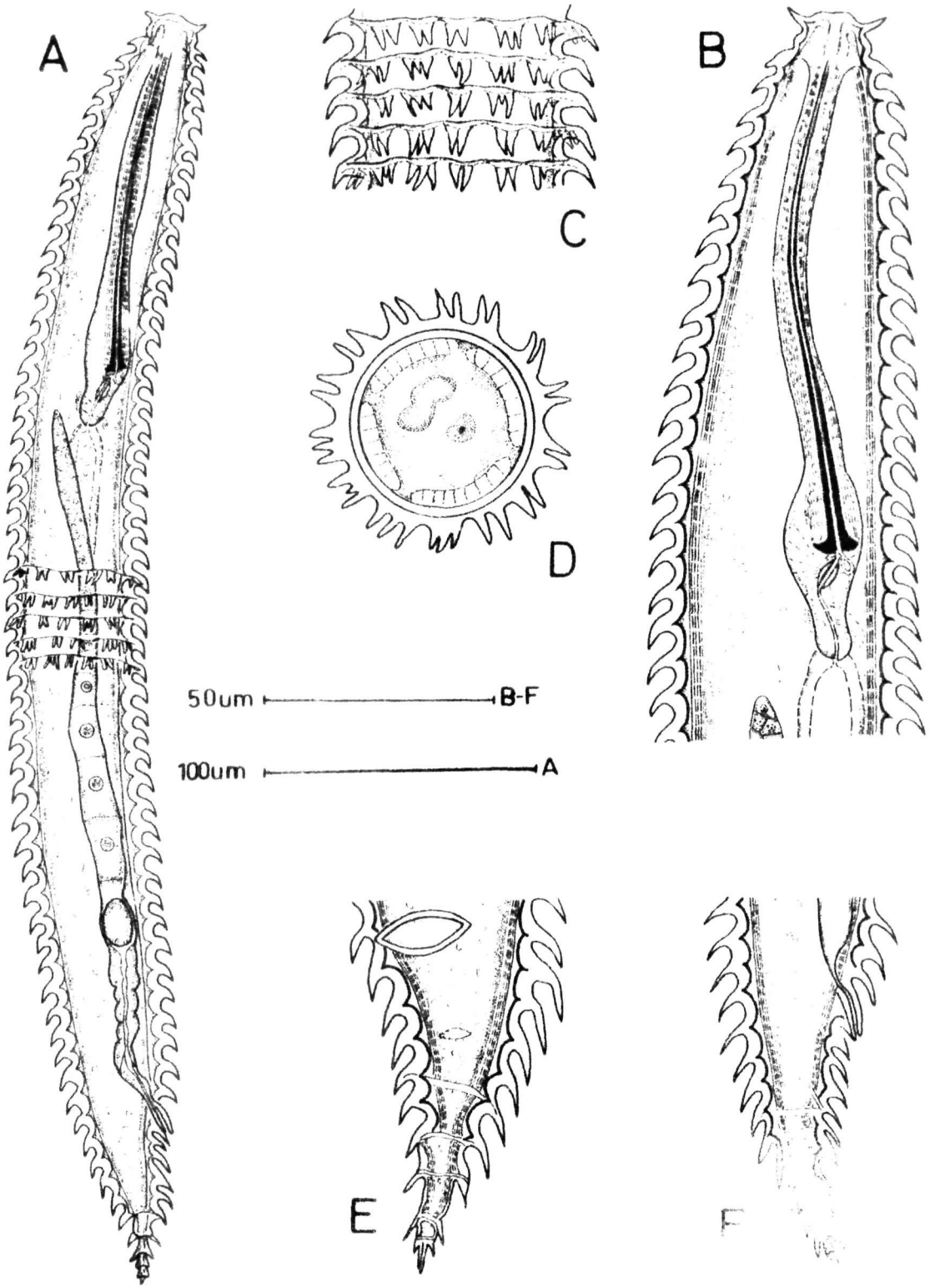

A
B
C
D
E
50um
B-F
100um
A

Fig. 21

[illegible] BASILI

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Surface of annules on midbody,

E & F - Posterior ends.

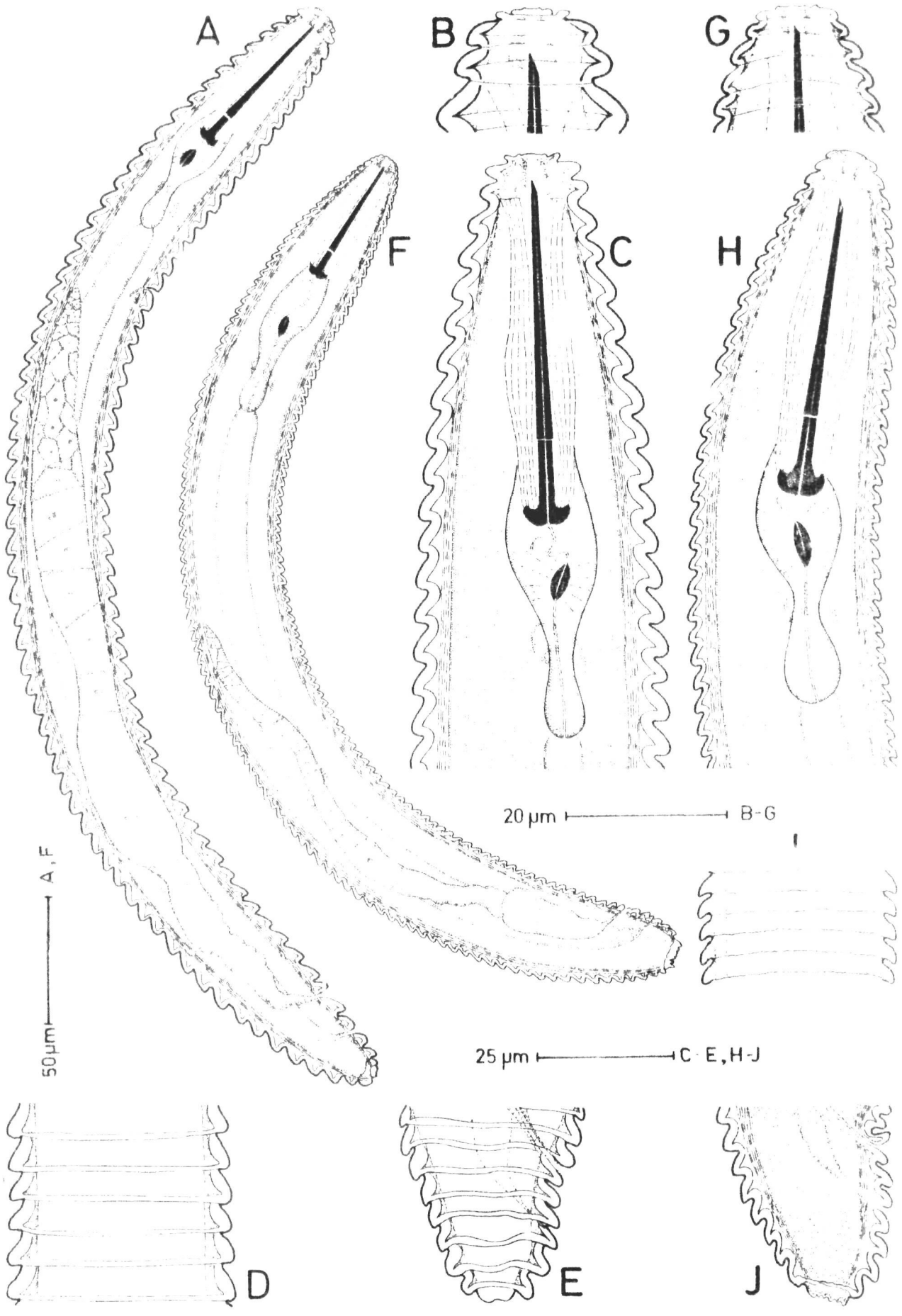

A
B
G
F
C
H
20 µm
B-G
A, F
50µm
25 µm
C-E, H-J
D
E
J

Fig. 23

A - C, [illegible]

A - Oesophageal region,

B - Surface of annules on midbody

C - Posterior end.

D - F, [illegible]

D - Oesophageal region,

E - Surface of annules on midbody,

F - Posterior end.

G - I, [illegible]

G - Oesophageal region,

H - Surface of annules on midbody,

I - Posterior end.

Fig. 23

A - C, [illegible]

A - Oesophageal region,

B - Surface of annules on midbody

C - Posterior end.

D - F, [illegible]

D - Oesophageal region,

E - Surface of annules on midbody,

F - Posterior end.

G - I, [illegible]

G - Oesophageal region,

H - Surface of annules on midbody,

I - Posterior end.

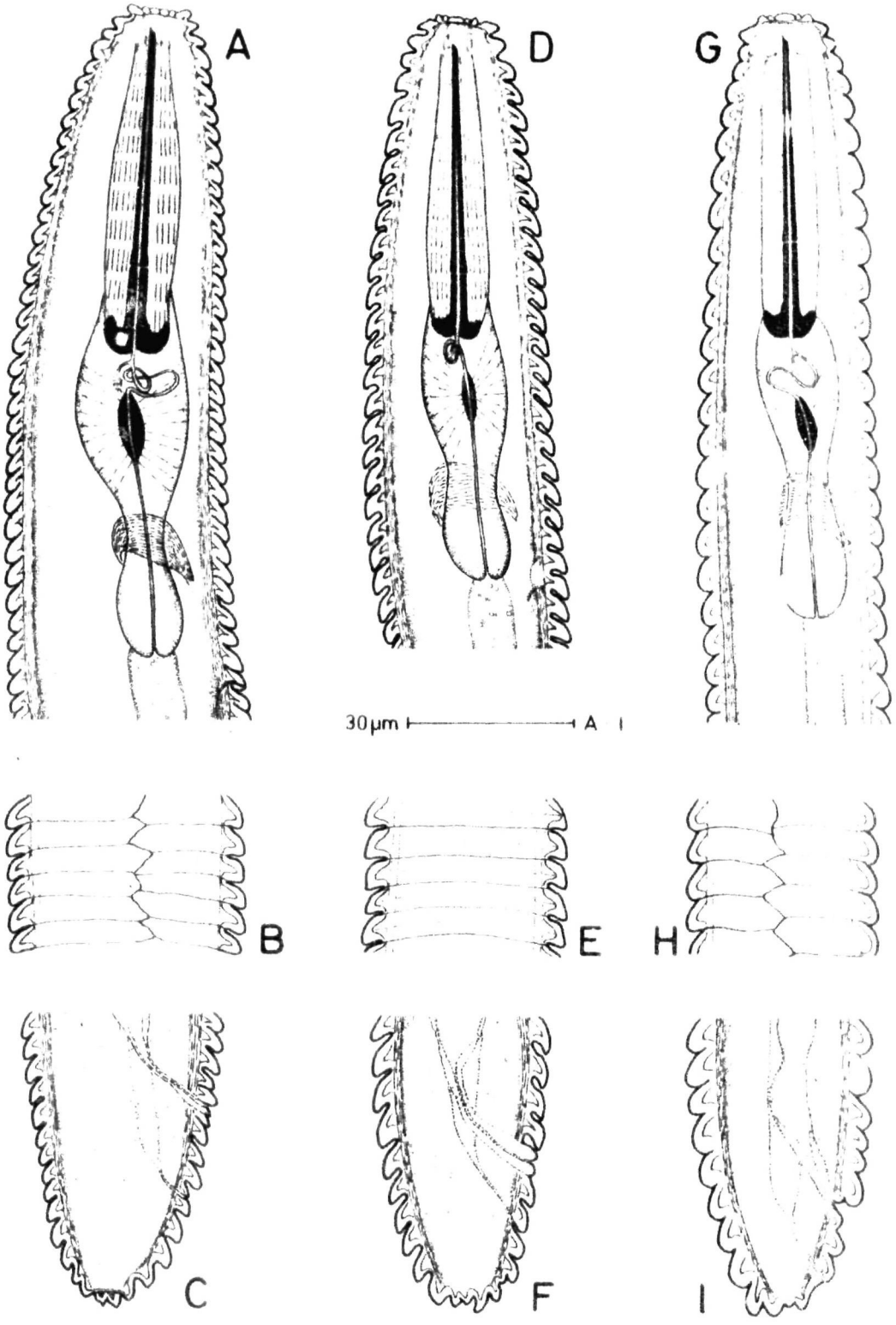

A
D
G
30µm
A
B
E
H
C
F
I

Fig. 24

[illegible]

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D & E- Surface of annules on midbody,

F - Posterior end.

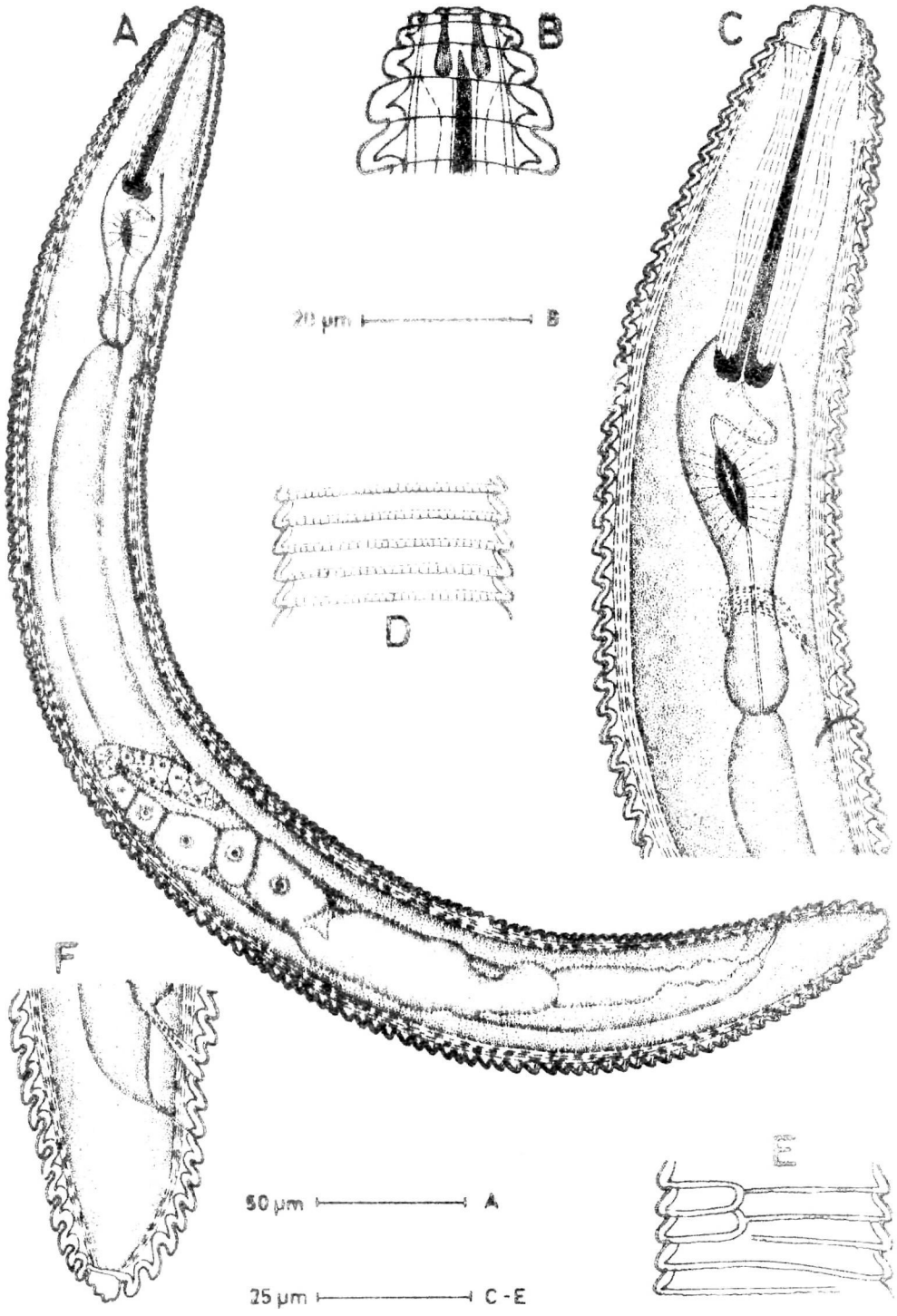

A
B
C
D
E
F
20 µm
B
50 µm
A
25 µm
C - E

Fig. 25

MACROCHONIA MIRI

A - Entire female.

B - Entire male.

C - Female anterior end.

D - Female oesophageal region.

E - Male anterior end.

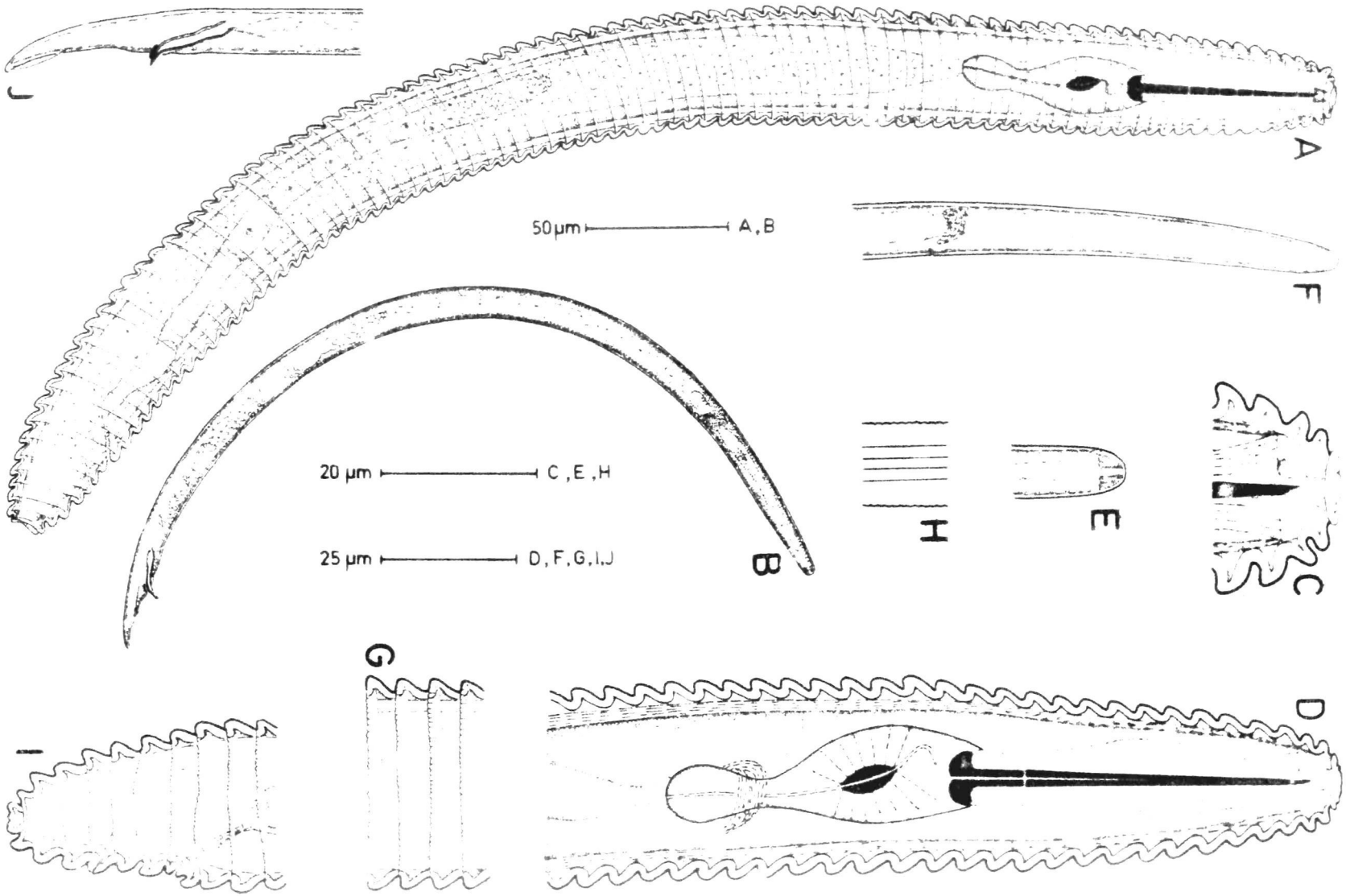
F - Male oesophageal region.

G - Surface of annules on midbody (female).

H - Lateral field (male).

I - Female posterior end.

J - Male posterior end.


50 µm
A, B
20 µm
C, E, H
25 µm
D, F, G, I, J
A
B
C
D
E
F
G
H
I
J

B
A
C
D
E
F
I
H
G
20 µm
C
50 µm
D-I
50 µm
E
50 µm
A

Fig. 29

[illegible] [illegible] [illegible] N. S.

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Surface of annules on midbody,

E - Posterior end.

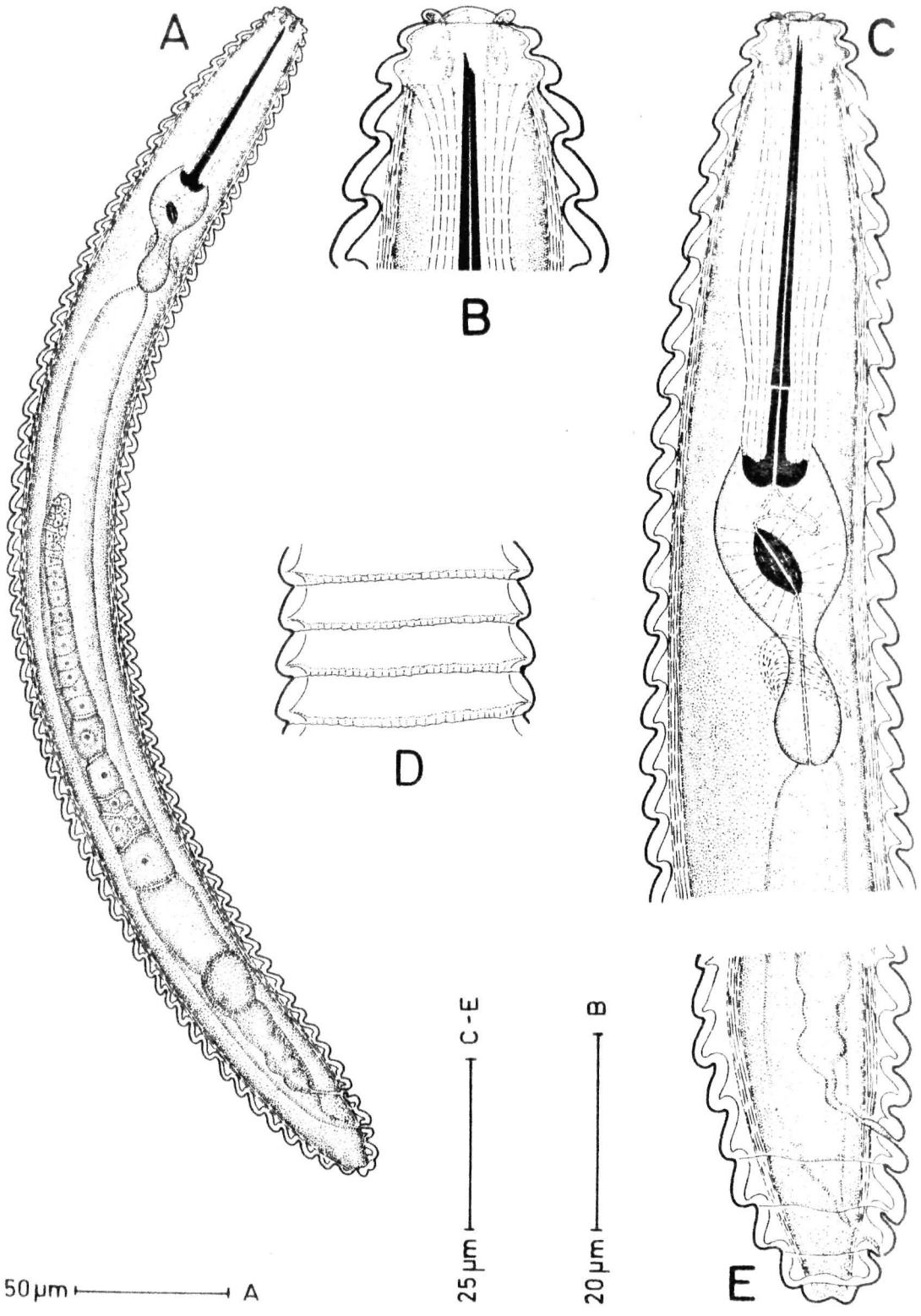

A
B
C
D
E
50 µm
A
25 µm
C-E
20 µm
B

Fig. 30

CHIONOECHUS NIGERIANUS n. sp.

A - Entire female.

B - Anterior end.

C - Oesophageal region.

D - Surface of annules on midbody.

E - Posterior end.

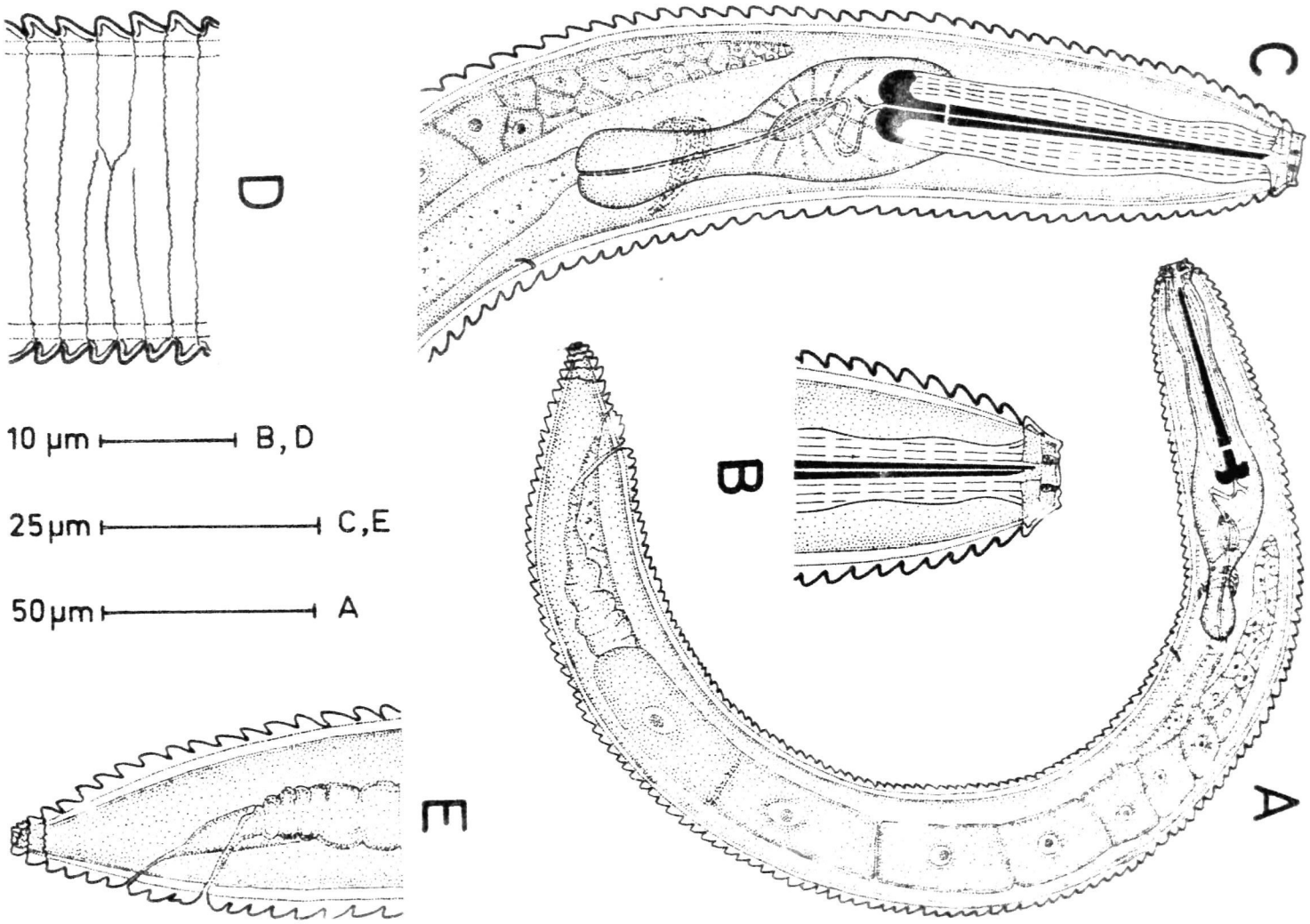

D
C
B
A
E
10 µm B, D
25 µm C, E
50 µm A

Fig. 31

[illegible] n. sp.

A - Entire female.

B - Oesophageal region.

C & D - Anterior ends.

E - Surface of annules on midbody

F - Posterior end.

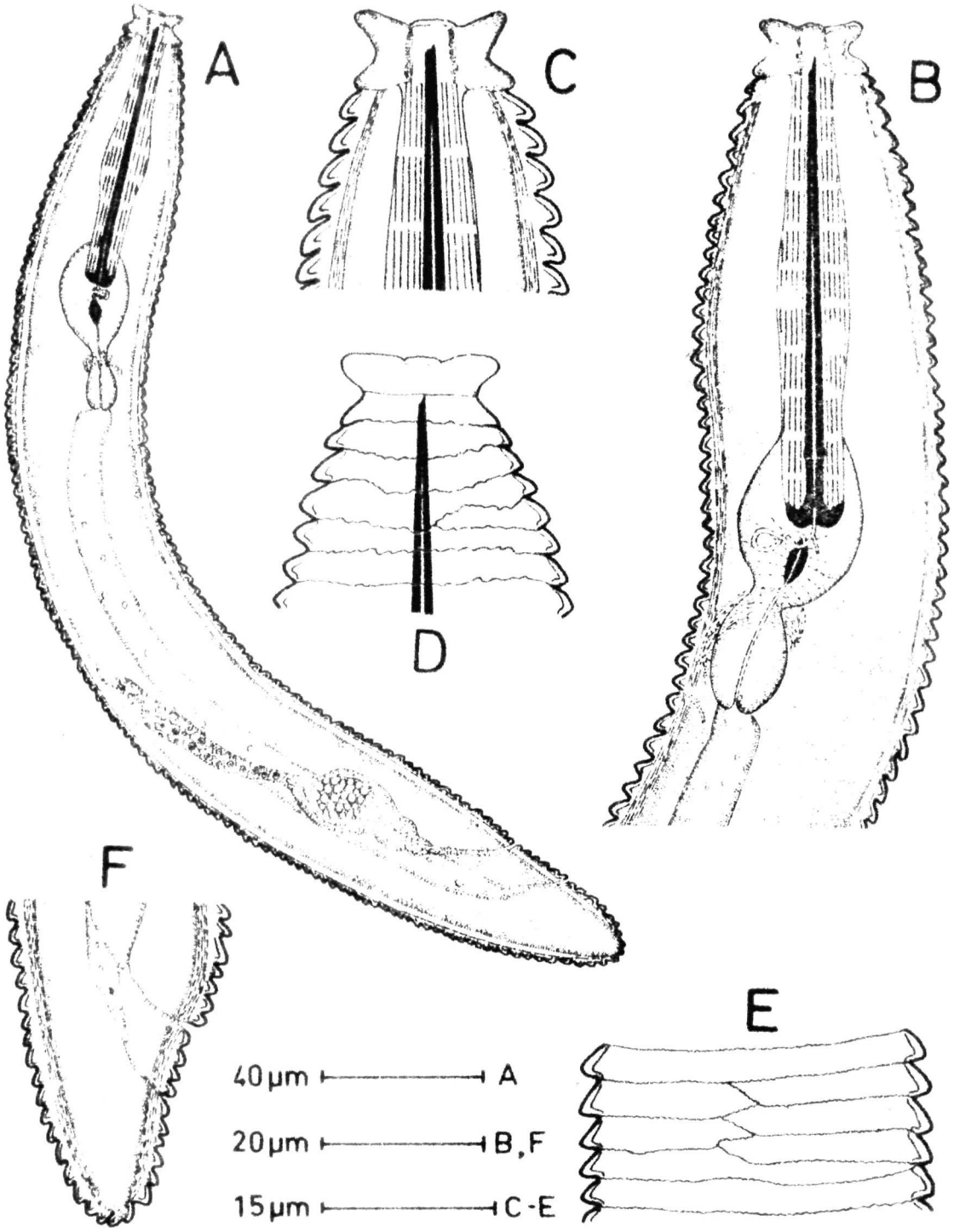

A
C
B
D
F
E
40 µm
A
20 µm
B, F
15 µm
C-E

Fig. 32

[illegible]

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Surface of annules on midbody,

E - Posterior end.

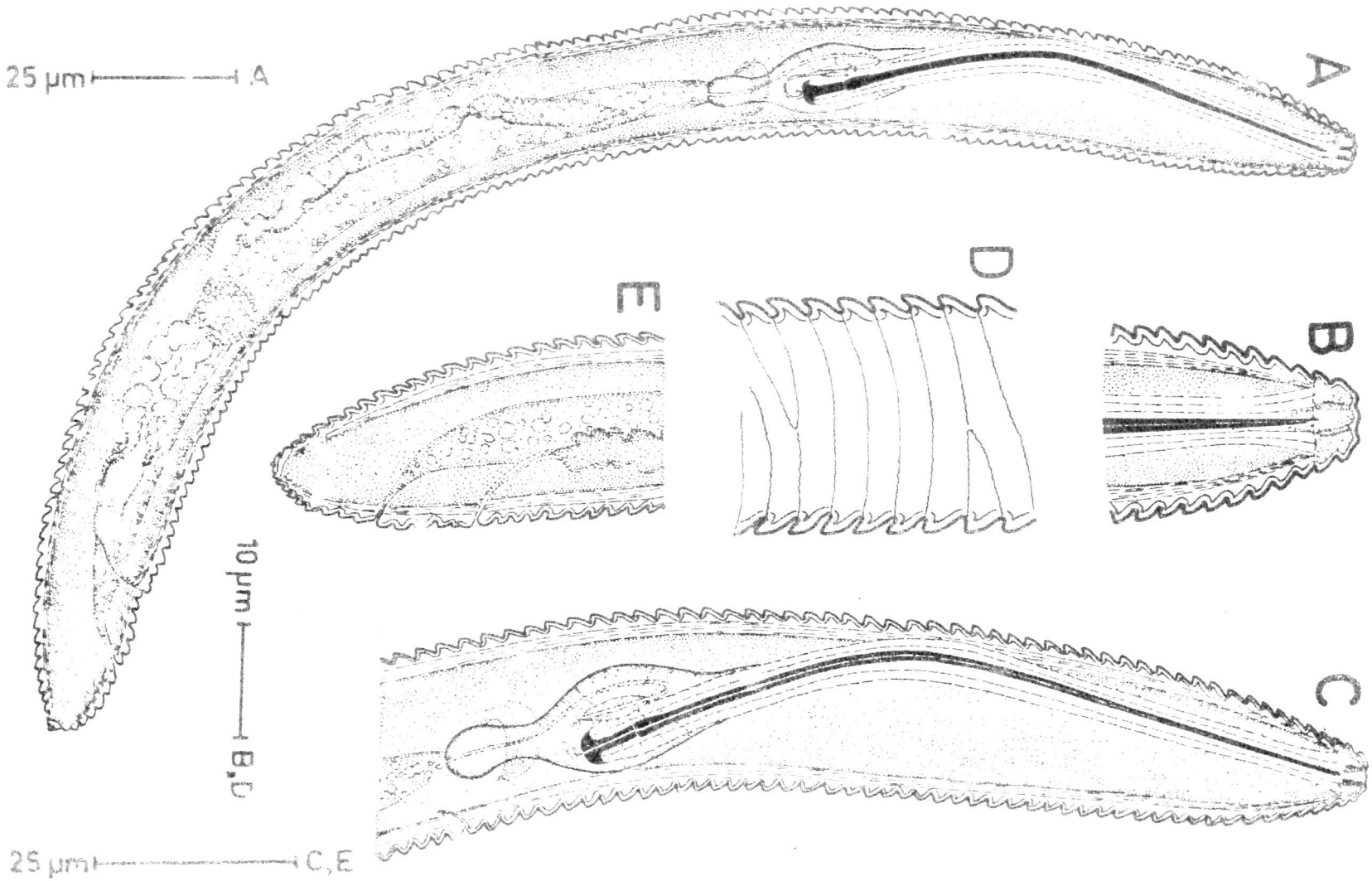

25 µm
A
A
D
E
B
10 µm
B,D
C
25 µm
C,E

Fig. 33

[illegible] [illegible]

A - Entire female,

B - Oesophageal region,

C - Anterior end,

D - Surface of annules on midbody,

E & F - Posterior ends.

A
C
B
D
E
F
30μm
C
50μm
B,D-F
100μm
A

Fig. 34

[illegible]

A - Entire female,

B - Female oesophageal region,

C - Female anterior end,

D - Entire male,

E - Male oesophageal region,

F - Female posterior end,

G - Male posterior end,

H - Lateral field (male).

C
A
D
E
B
H
30µm
B, E - G
70µm
A, D
30µm
C
15µm
H
G
F

A
B
C
D
E
F
G
H
I
50µm
A,B
25µm
D,E,H,I
20µm
C,F,G

Fig. 36

HELICOCERCOIDES IRRICUS n. sp.

A - Entire female.

B & C - Anterior ends.

D - Oesophageal region.

E - Surface of annules on midbody.

F, G & H - Posterior ends.

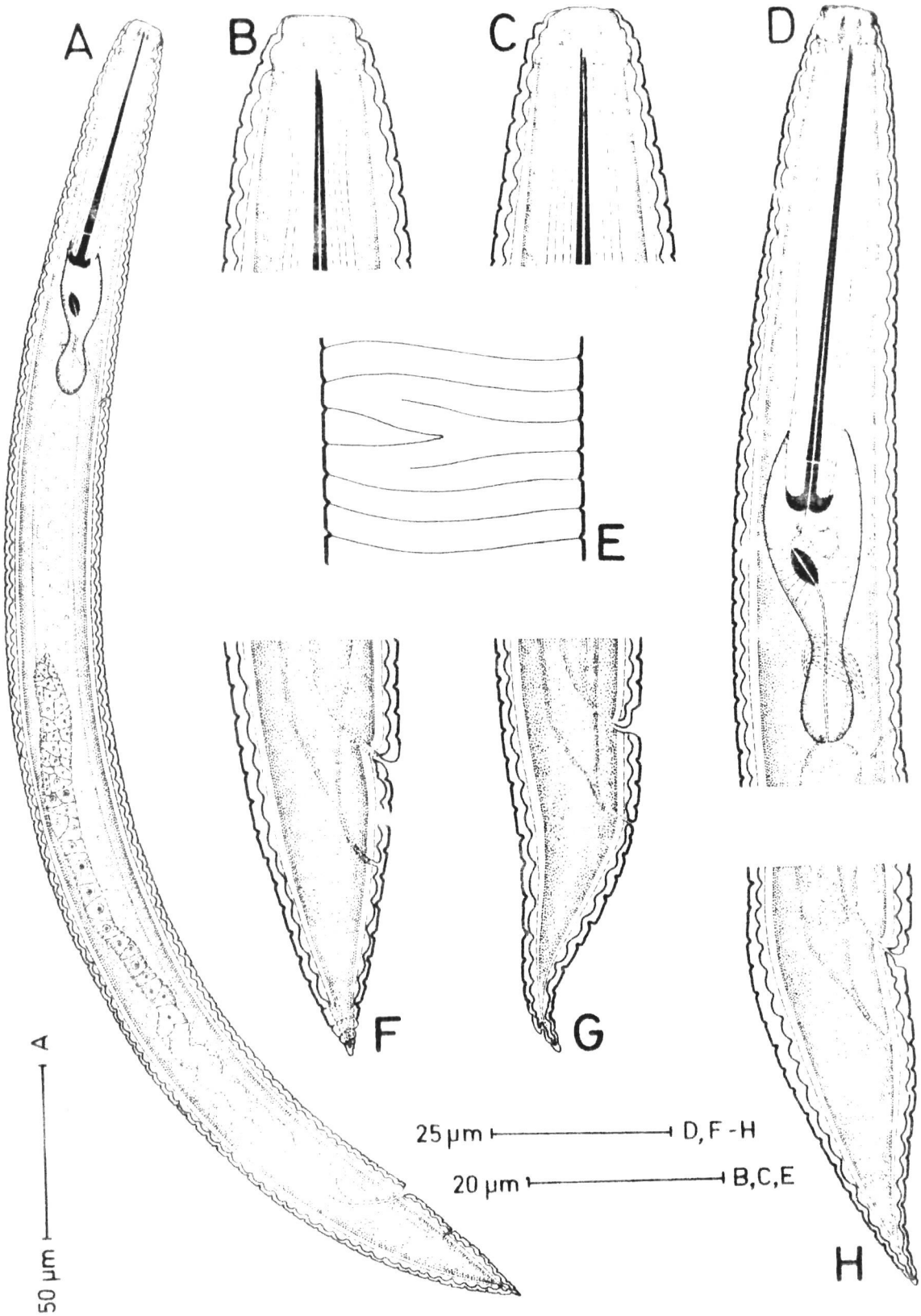

A
B
C
D
E
F
G
H
A
50 µm
25 µm
D, F - H
20 µm
B, C, E

Fig. 37

[illegible] sp.

A - Entire female,

B, C, D & E - Anterior ends,

F - Oesophageal region,

G - Surface of annules on midbody,

H, I, J & K - Posterior ends.

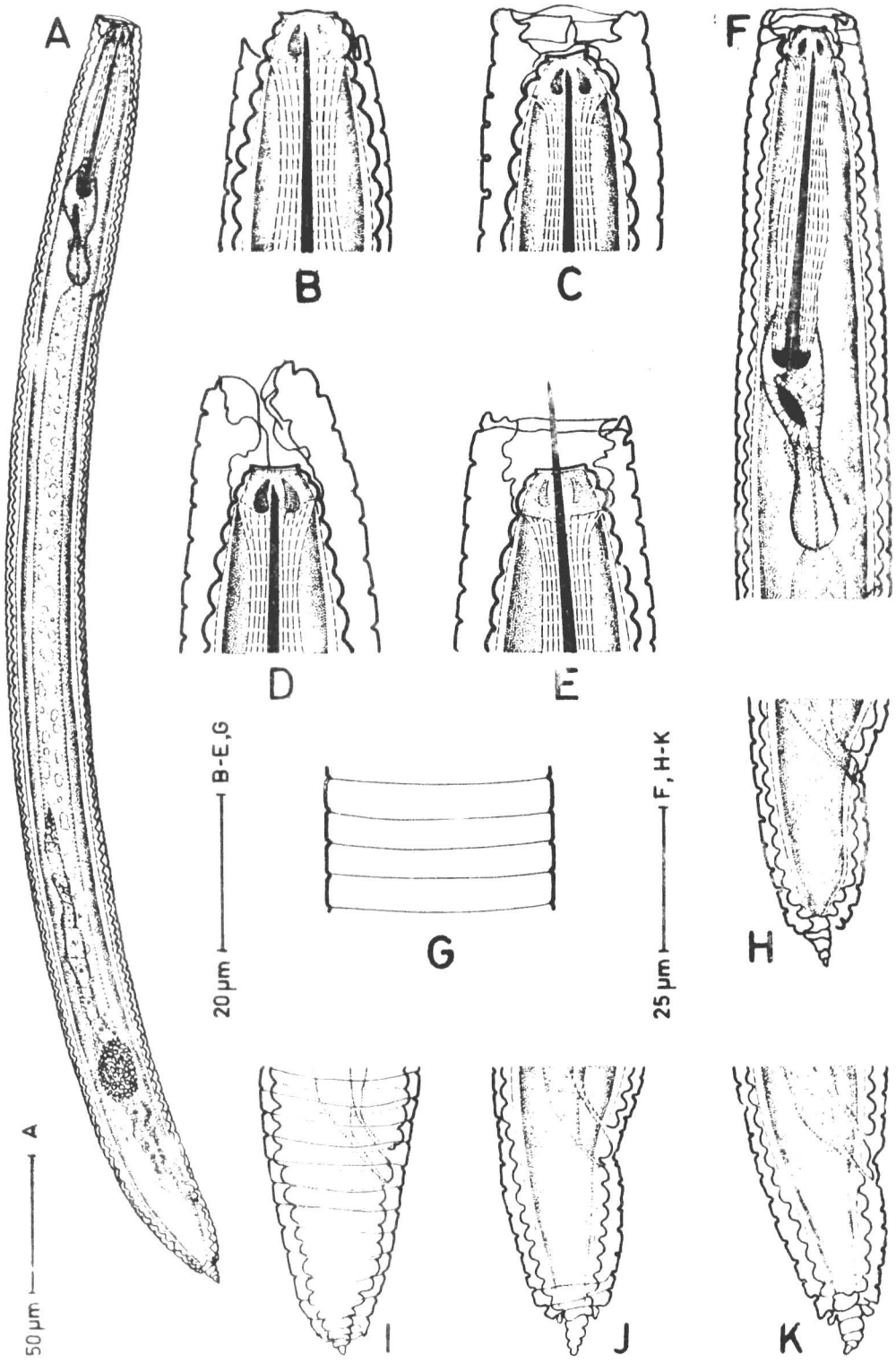

A
B
C
F
D
E
G
H
I
J
K
50 µm
A
20 µm
B-E,G
25 µm
F, H-K

Fig. 30

[illegible]

A - Entire female

B - Female anterior end,

C - Female oesophageal region,

D - Female cuticular pattern.

E - Female posterior end,

F - Male entire,

G - Male anterior end,

H - Male oesophageal region,

I - Male lateral field,

J - Male posterior end.

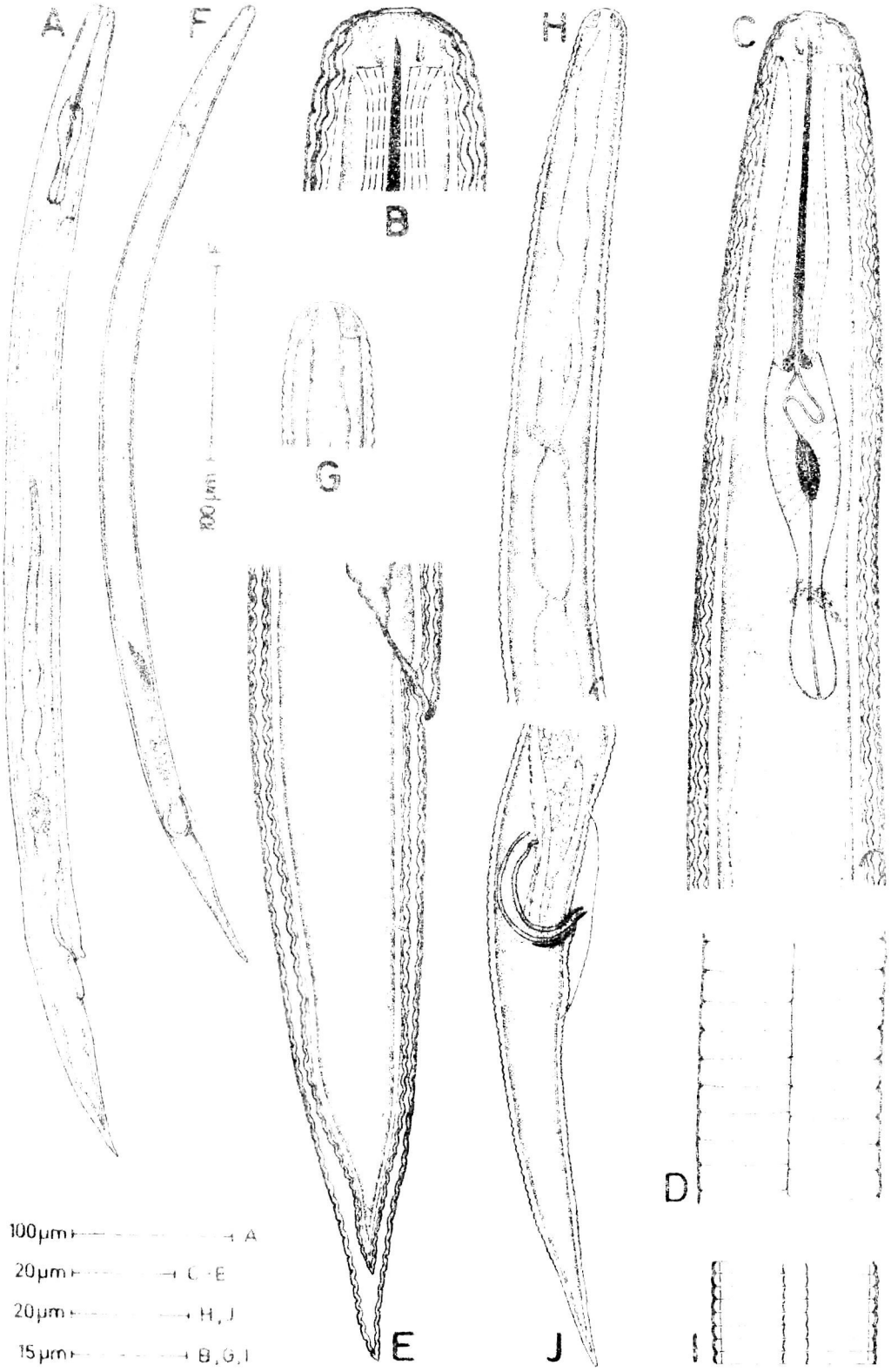

A
F
B
H
C
G
D
E
J
100 µm
A
20 µm
C - E
20 µm
H, J
15 µm
B, G, I

Fig. 39

[illegible] sp. N. sp.

A - Entire female,

B - Oesophageal region,

C - Anterior end,

D - *En face* view

E - Cross-section through midbody,

F - Cuticular pattern,

G - Gonad,

H - Posterior end.

A
B
C
D
E
F
G
H
60µm
G
150µm
A
35µm
B,E,H
25µm
C,D,F

Fig. 40

HELICYCLOPHORA PSEUDOMOLICA N. SP.

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Cuticular pattern,

E - Posterior region, showing vulva and anus (dorsoventral),

F - Posterior end.

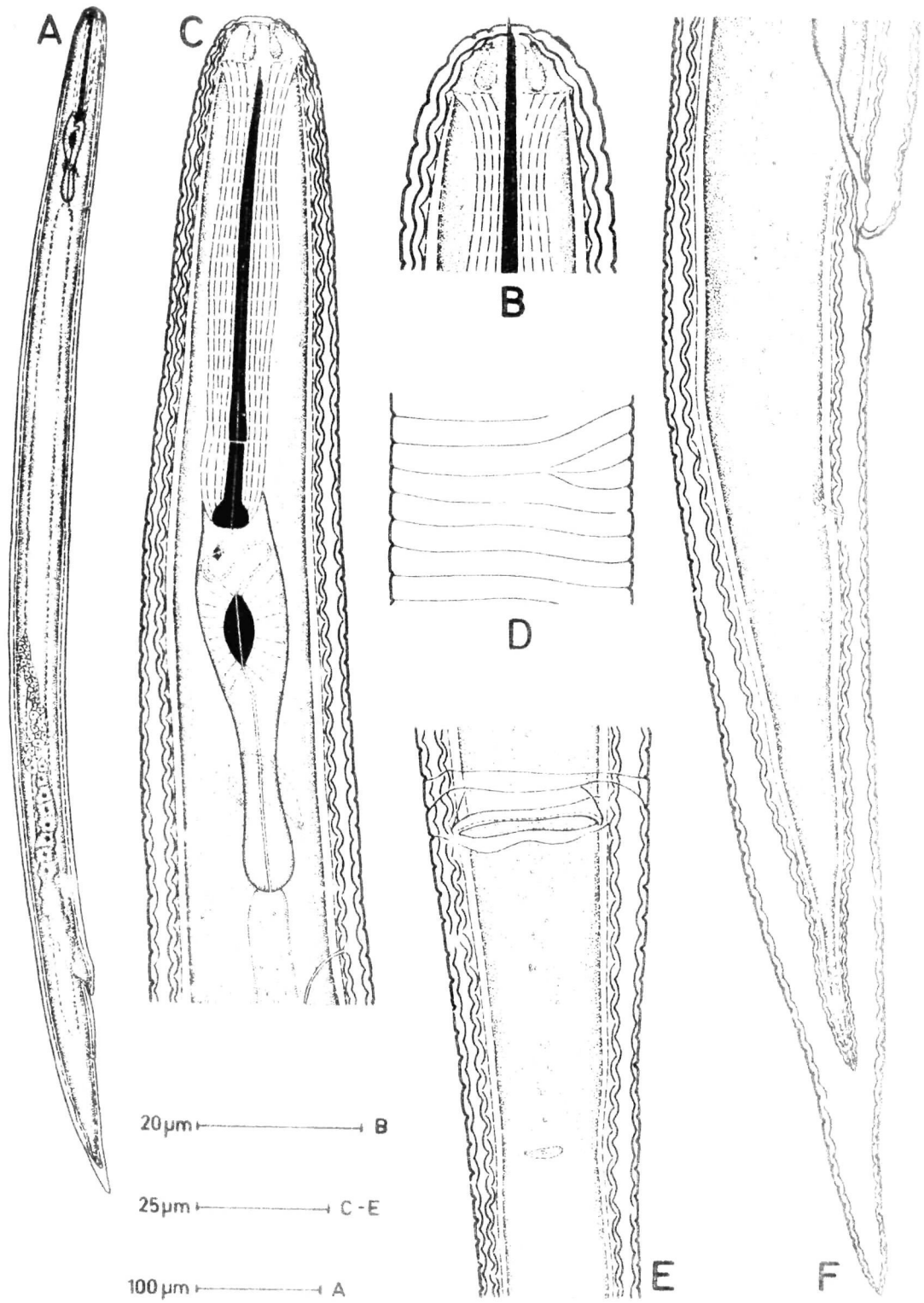

A
C
B
D
E
F
20 µm
B
25 µm
C - E
100 µm
A

Fig. 41

[illegible]

A - Entire female.

B - Oesophageal region.

C - Anterior end.

D - Anterior end showing lip sleeve.

E - Cuticular pattern.

F - Posterior end.

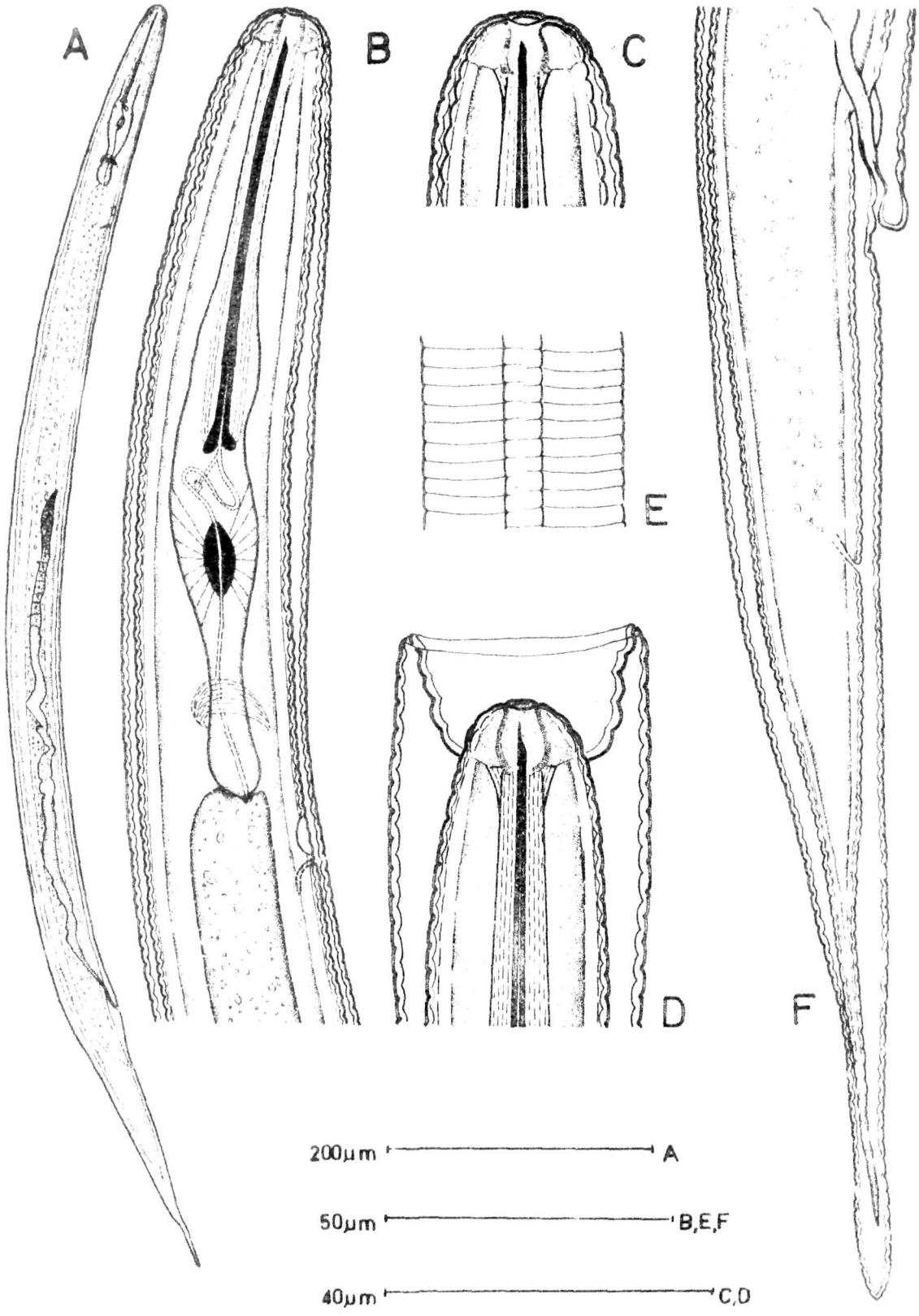

A
B
C
E
D
F
200µm
A
50µm
B,E,F
40µm
C,D

Fig. 42

[illegible]

A - Entire female,

B - En face view

C - Anterior end,

D - Oesophageal region,

E - Cuticular pattern,

F - Posterior end.

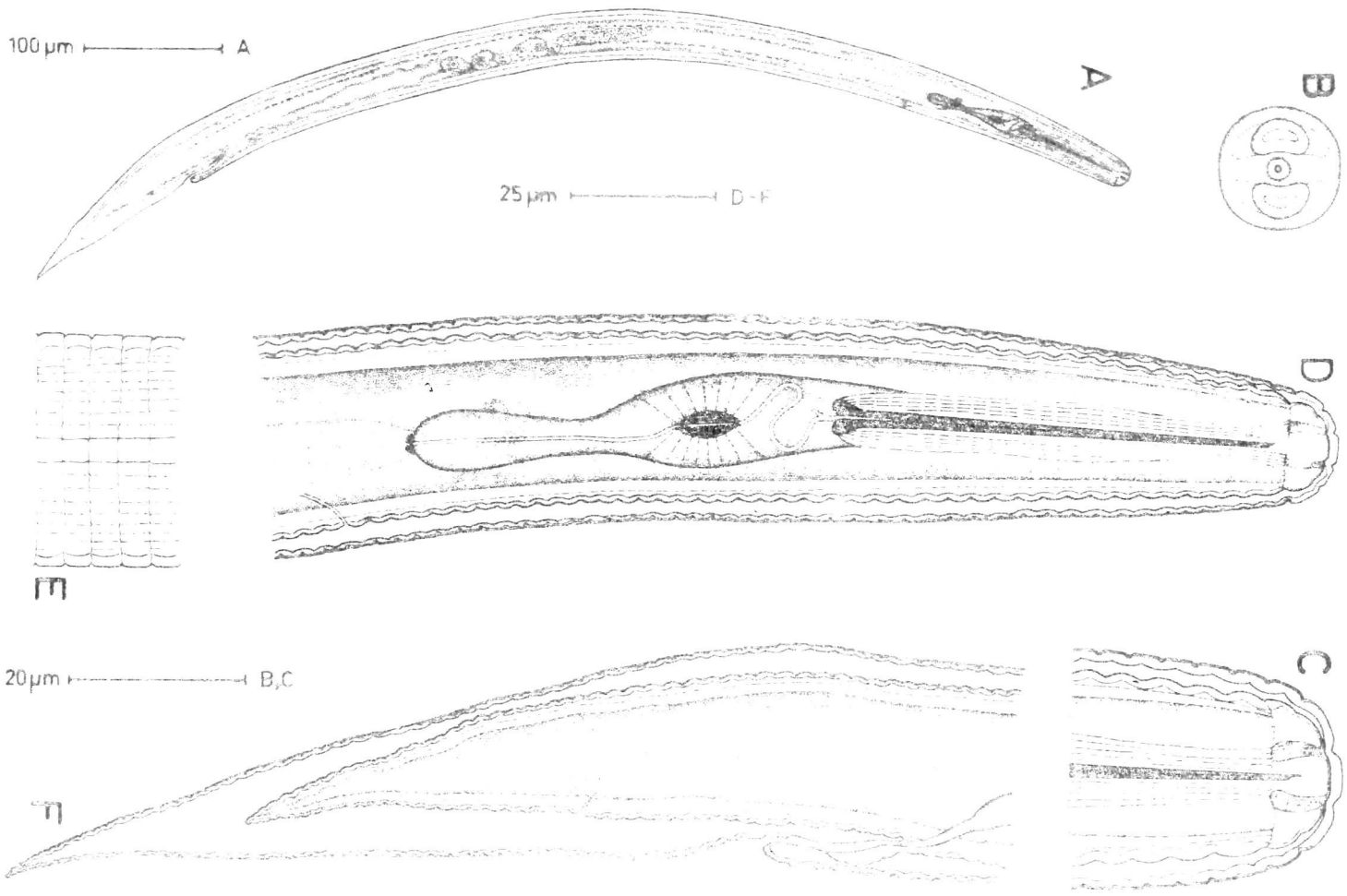

100 µm
A
A
B
25 µm
D - F
D
E
20 µm
B,C
C

Fig. 43

Cephalobus [illegible]

A - Entire female,

B - Entire male,

C - Female oesophageal region,

D - Male oesophageal region,

E - Female anterior end,

F - Male anterior end,

G - Male lateral field,

H - Female posterior end,

I - Male posterior end,

J - Male posterior end.

A
B
C
D
E
F
G
H
I
J
50µm
C,D,G,J
30µm
E,F
100µm
H,I
300µm
A,B

Fig. 44

CRICONEMA PARAANGICAUDATA

A - Entire female.

B - Entire male.

C - Female anterior end.

D - Male anterior end.

E - Female oesophageal region.

F - Female posterior end.

G - Male posterior end (dorsoventral).

B
A
C
E
D
F
G
50 µm
F
C,D
10 µm
A
100 µm
B
100 µm
E,G
40 µm

Fig. 45

PARATYLENCHUS BICORNIATUS

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Region of oesophageal bulb showing location of excretory pore,

E - Lateral field,

F - Posterior end.

A
B
C
F
D
E
50 µm
A
25 µm
C,F
10 µm
B,D,E

Fig. 46

[illegible]

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Region of oesophageal bulb showing location of excretory pore,

E - Lateral field,

F - Posterior end.

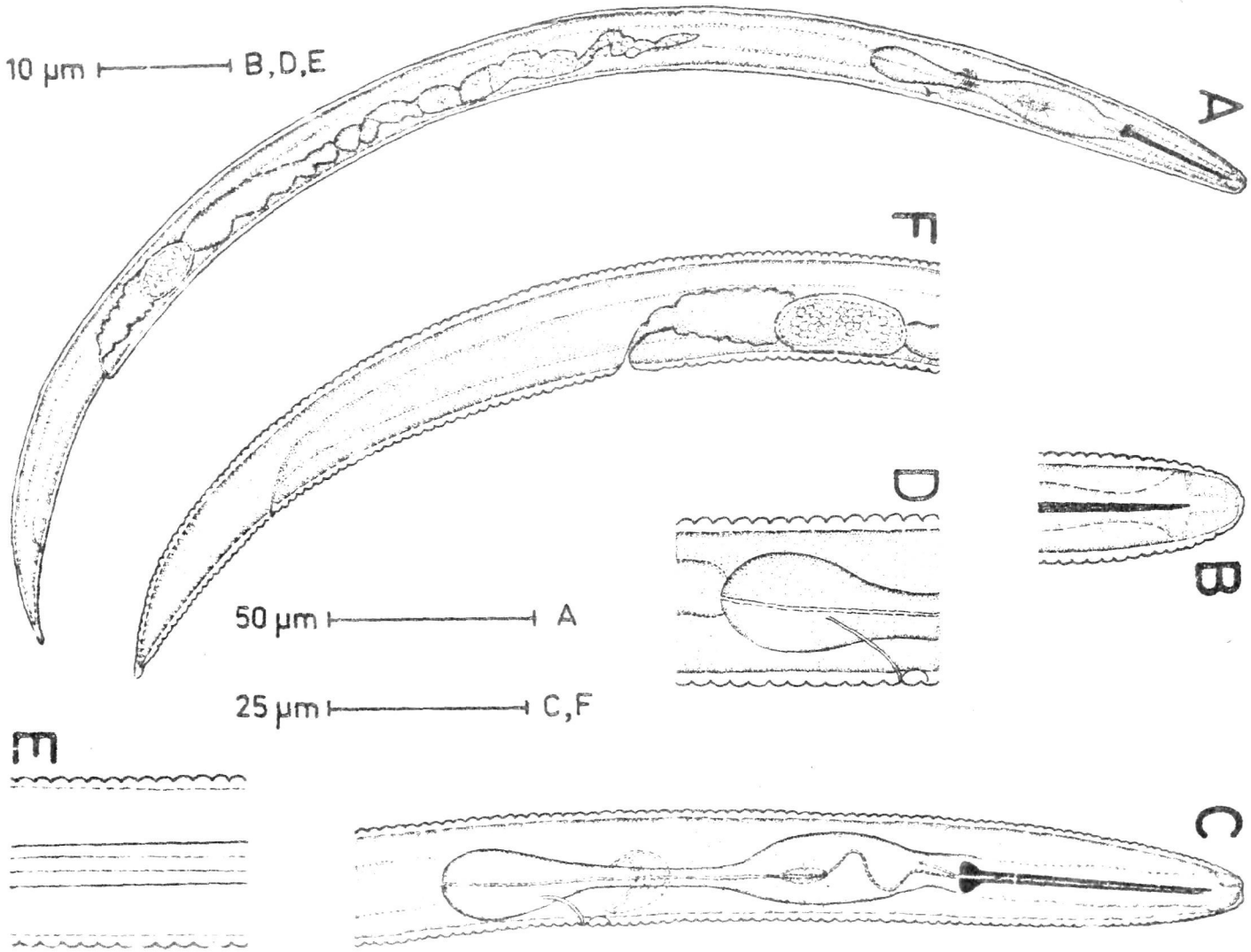

10 µm
B,D,E
A
F
D
B
50 µm
A
25 µm
C,F
E
C

Fig. 47

PARATYLENCHUS LILLOCULUS

A – Entire female,

B – Anterior end,

C – Oesophageal region,

D – Region of oesophageal bulb showing location of excretory pore,

E – Lateral field,

F – Posterior end.

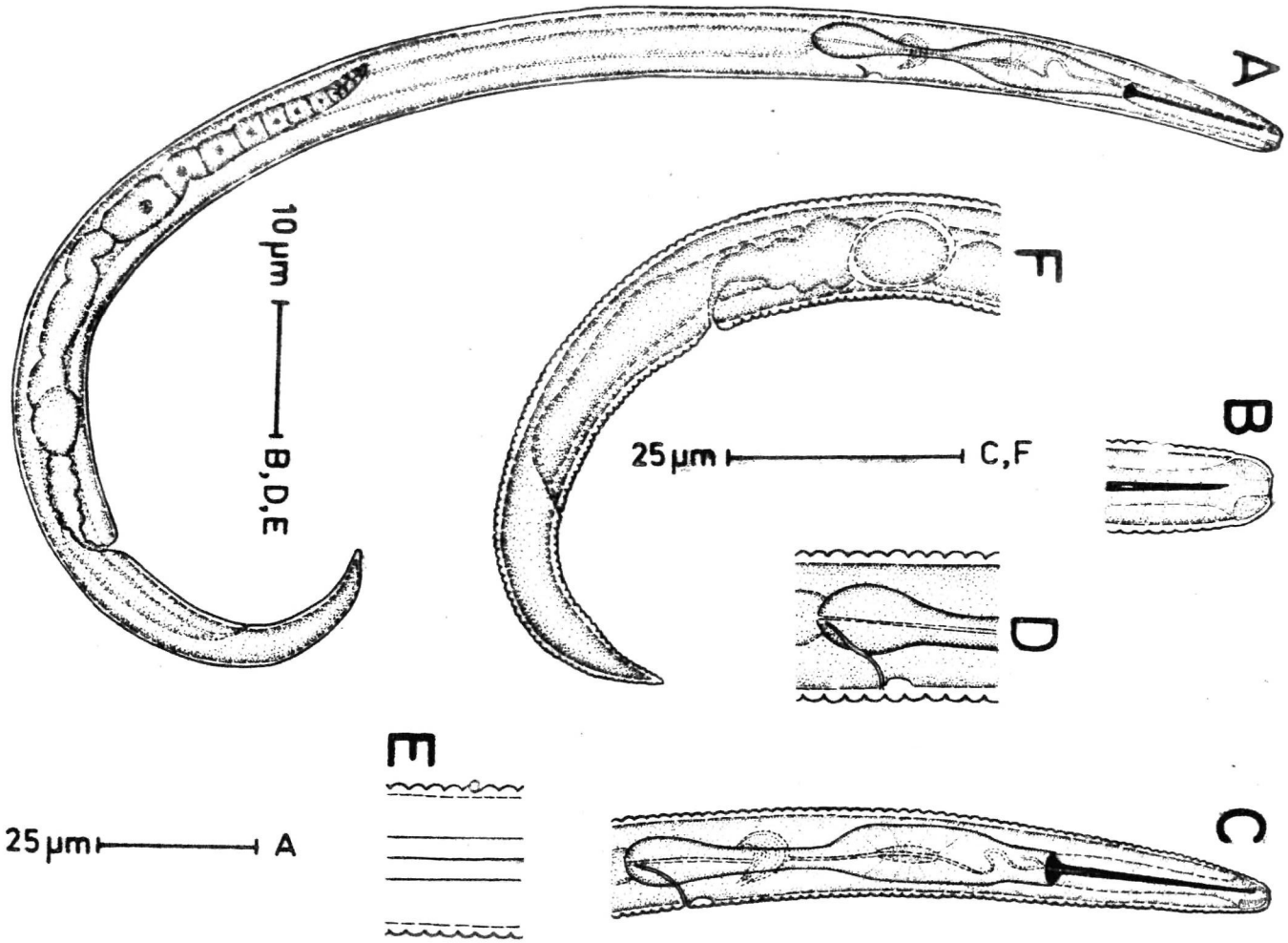

A
10 µm
B,D,E
F
25 µm
C,F
B
D
E
25 µm
A
C

Fig. 48

PRATYLENCHUS PALLIDUS

A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Lateral field,

E - Posterior end.

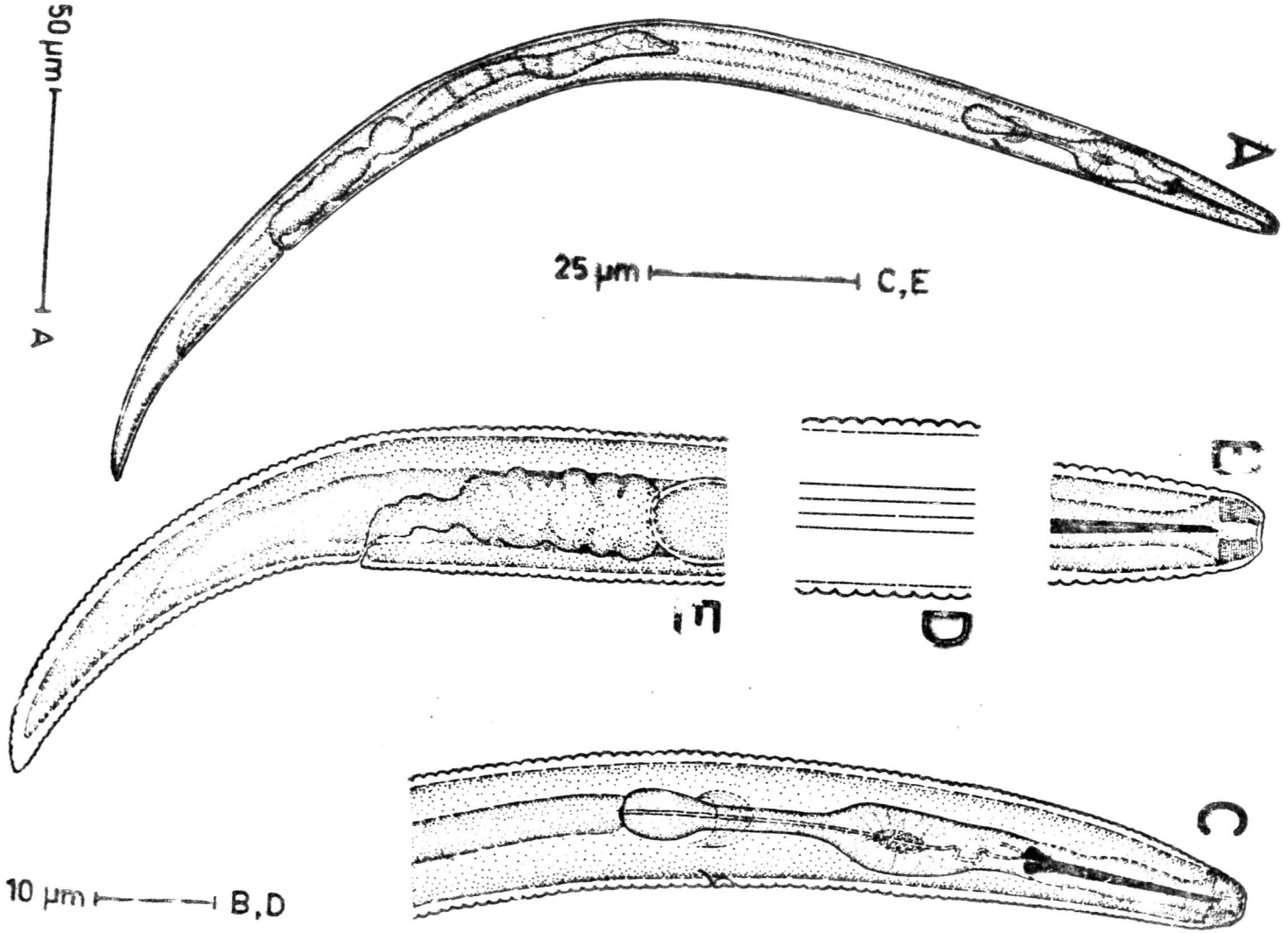

50 µm
A
25 µm
C,E
A
B
D
E
C
10 µm
B,D

Fig. 49

CRACILACUS AURIELLUS

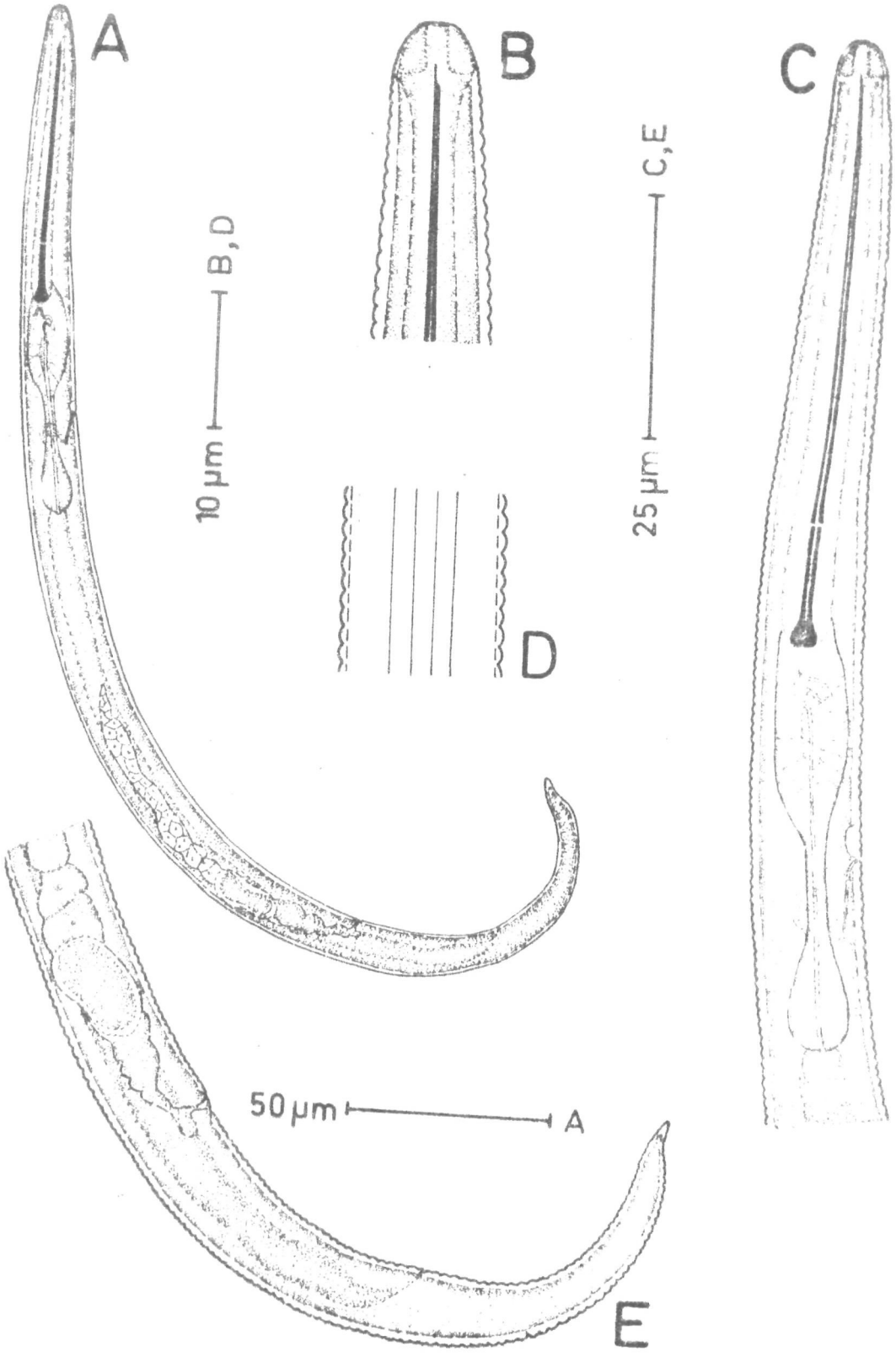
A - Entire female,

B - Anterior end,

C - Oesophageal region,

D - Lateral field,

E - Posterior end.


A
B
C
D
E
B, D
10 µm
C, E
25 µm
50 µm
A